CIVIL ENGINEERING

ROUGH GOING ON PIPELINE IN BRITISH COLUMBIA. SEE ARTICLE BY BECHTEL . . . PIPELINES — A FIELD FOR CIVIL ENGINEERS

Main water supply line by American Pipe and Construction C

Torrance, California

'Backbone of the System'

says **Angus E. McVicar**
Torrance, California
Water Superintendent

Concentration of industry and a population that has tripled since 1950 posed a serious water problem for the city of Torrance, California. Although ample water was available from the Metropolitan Water District of Southern California, only one of the city's three water systems was tied into the District's supply line and the city's principal growth was in two areas supplied independently by wells and reservoirs.

Solution was the installation of 22,000′ of 24″ American Concrete Cylinder Pipe which coordinated all three systems and allowed distribution of Metropolitan water wherever desired. "The new line is the backbone of the system," says Angus E. McVicar, Torrance water superintendent. The installation of American Concrete Cylinder Pipe now provides Torrance with a permanent, maintenance-free water supply line of sustained carrying capacity and virtually limitless life.

American Pipe makes available 49 years of experience and extensive production facilities to help solve any water supply problem. There is a type of American Pipe to meet any requirement. Write or phone for complete information.

Main offices and plant: 4635 Firestone Blvd., South Gate, Calif.—Phone LOrain 4-2511

Mail address: Box 3428 Terminal Annex, Los Angeles 54

District sales offices and plants: Hayward and San Diego, Calif.—Portland, Ore.

8603

American PIPE AND CONSTRUCTION CO.

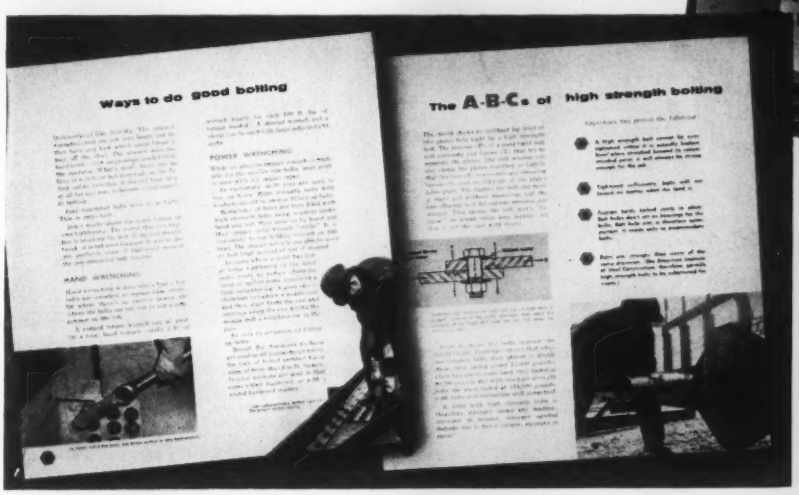
CONCRETE PIPE FOR MAIN WATER SUPPLY LINES, STORM AND SANITARY SEWERS, SUBAQUEOUS LINES

New RB&W Booklet gives the plain facts on bolting

...a big help for steel constructors

THIS NEW instructive booklet was prepared with ironworkers in mind. Quickly and to the point, it gives all the information a man needs in order to use high strength bolts to make a better steel joint . . . whether he's erecting a building or bridge, or repairing equipment.

It's timely information, too. More and more buildings are now being bolted instead of riveted. RB&W is proud to have pioneered in this development. Send for free copies of this booklet – and tell us how many you want for your men.



RUSSELL, BURDSALL & WARD BOLT AND NUT COMPANY
Port Chester, New York

Plants at: Port Chester, N. Y.; Coraopolis, Pa.; Rock Falls, Ill.; Los Angeles, Calif. **Additional sales offices at:** Ardmore (Phila.), Pa.; Pittsburgh; Detroit; Chicago; Dallas; San Francisco. **Sales agents at:** Milwaukee, New Orleans, Denver, Seattle. **Distributors** from coast to coast.

R B&W
110th year

... the largest independent producer of high strength bolts for construction

CIVIL ENGINEERING, June 1956. Vol. 26, No. 6. Published monthly by the American Society of Civil Engineers. Publication office 20th and Northampton Streets, Easton, Pa. Editorial and advertising departments at ASCE Headquarters, 33 West 39th St., New York 18, N. Y. Entered as second class matter September 23, 1930, at the Post Office, Easton, Pa., under Act of August 24, 1912, and accepted for mailing at special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized on July 5, 1918.

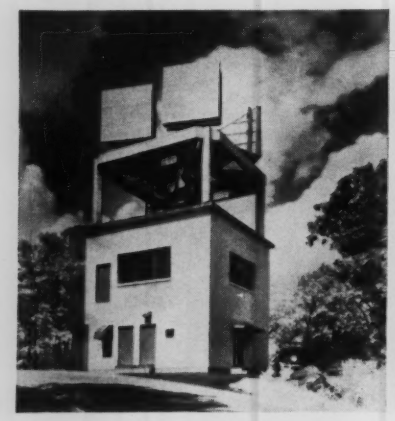
BORDEN first IN FLOOR GRATING

USES OF GRATING . . . WHERE ONLY BORDEN QUALITY WOULD DO . . .

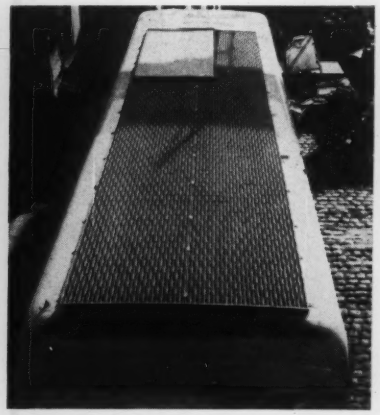
Here on this page are a few of the many new or unusual uses for grating being pioneered every day. Each is an exacting job where only standards of quality equal to BORDEN'S will do.

And remember . . . BORDEN manufactures every type grating in ferrous and non-ferrous metals.

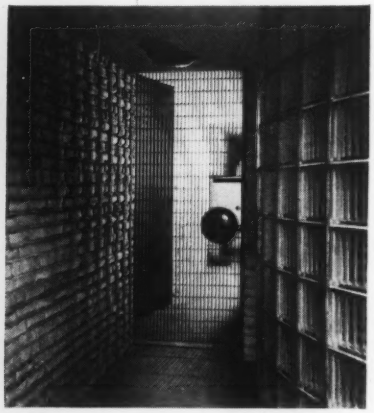
GRATING PLATFORMS for Scales . . . Will not collect snow, ice or become waterlogged; need balancing much less frequently; require no maintenance, yet bring you years of reliable service.



Television relay stations and radar stations that gird our continent have adopted grating as standard outside platform material. It will not collect snow as most other platforms will.



Wherever this Color Television truck goes, whatever the assignment of the reporters who must mount its roof, Borden riveted *serra-crimp* grating will mean surerfooting —even in ice or snow.



Only the finest precision manufacturing would satisfy the architect who designed this door. BORDEN is recognized as a leader in quality, custom-manufactured gratings.

See our Catalog in Sweets

Write for complete information on BORDEN All/Weld, Pressure Locked, and Riveted Floor Gratings in this FREE 8-page catalog

BORDEN METAL PRODUCTS CO.

845 GREEN LANE Elizabeth 2-6410 ELIZABETH, N. J.
SOUTHERN PLANT—LEEDS, ALA.—MAIN PLANT—UNION, N. J.

BORDEN METAL PRODUCTS CO.

Gentlemen:

Please send me BORDEN Catalog

NAME .....

TITLE .....

COMPANY NAME .....

ST. AND NO. .....

CITY AND STATE .....

Editor • Walter E. Jessup
Executive Editor • Robert K. Lockwood
Associate Editor • Ruth G. Campbell
News Editor • Mary E. Jessup
Assistant Editor, Production • Anita G. Newman

Advertising Manager • James T. Norton

Drafting • Frank J. Loeffler

EDITORIAL & ADVERTISING DEPARTMENTS of ASCE Headquarters, 33 West 39th Street, New York 18, N.Y.

Advertising Representatives
are listed on Index to Advertisers page

ASCE BOARD OF DIRECTION

President

Enoch R. Needles

Vice Presidents

Glenn W. Holcomb — Frank A. Marston
Louis R. Howson — Frank L. Weaver

Directors

Carey H. Brown — Samuel B. Morris
Ernest W. Carlton — Frederick H. Paulson
Don M. Corbett — George S. Richardson
Raymond F. Dawson — John P. Riley
Clarence L. Eckel — R. Robinson Rowe
L. A. Elsener — Louis E. Rydell
Jewell M. Garrelts — Thomas C. Shedd
Oliver W. Hartwell — Robert H. Sherlock
W. S. LaLonde, Jr. — G. P. Willoughby
Mason C. Prichard

Past Presidents

Daniel V. Terrell — Wm. Roy Glidden

EXECUTIVE OFFICERS

Executive Secretary • William H. Wisely
Assistant Secretary • E. Lawrence Chandler
Treasurer • Charles E. Trout
Assistant Treasurer • Carlton S. Proctor

The Society is not responsible for any statements made or opinions expressed in its publications.

Subscription Rates—Price 50 cents a copy. $5.00 a year in advance; $4.00 a year to members and to libraries; and $2.50 a year to members of Student Chapters. Canadian postage 75 cents, and postage to all other countries outside of the United States and possessions, $1.50 additional.

Printing—Reprints from this publication may be made on condition that full credit be given to the author, copyright credit to Civil Engineering, and that date of original publication be stated.

© Copyright, 1956, by American Society of Civil Engineers. Printed in U.S.A. by Mack Printing Co.

Member Audit Bureau of Circulations

44,600 copies of this issue printed

CIVIL ENGINEERING

JUNE 1956
VOL. 26 • NO. 6

THE MAGAZINE OF ENGINEERED CONSTRUCTION

• ARTICLES

Arthur G. Beaulieu 33 **To save school construction dollars—look to the foundation**
K. R. Scurr 38 **Welded-stud shear connectors for South Dakota bridge**
E. R. Harrington 41 **Engineering education—four-year course favored**
John H. Patterson 42 **Taming the Long Sault Rapids**
H. Kent Preston 46 **Wire and strand for prestressed concrete**
Vincent J. Murphy 50 **Seismic profiles speed quantity estimates for turnpike**
Harold S. Davis 52 **High-density concrete for reactor construction**
Report of EJC 56 **Are employment conditions consistent with full professional stature?**
Stephen D. Bechtel, Jr. 61 **Pipelines—a field for civil engineers**
A. S. Krefting 66 **Culvert and 30-ft fill solve bridge replacement problem**
C. F. Ende 67 **A short-cut to plotting parabolas**

• SOCIETY NEWS

69 **Kansas City Conference appraises new member services of Technical Divisions**
70 **Hydraulics Division Conference to be held in Madison**
72 **Local Sections sponsor large regional conferences**
73 **ASCE recognizes Student Chapter work**
74 **From ASCE Student Chapters**
75 **Notes from the Local Sections**

• NEWS BRIEFS

82 **Construction activity continues seasonal advance in April**
82 **Water is too cheap, AWWA told**
83 **Twin-tube tunnel sections fabricated for Baltimore Harbor crossing**
84 **Hiwassee Dam has largest reversible pump-turbine unit**
88 **GM Research Center—where today meets tomorrow**
88 **ASEE study affirms value of liberal education**

• DEPARTMENTS

20 News of Engineers
31 Do You Know That
66 Engineers' Notebook
68 The Readers Write
78 Scheduled ASCE Conventions
92 N. G. Neare's Column
100 Deceased
109 New Publications
110 Recent Books
139 **Proceedings Papers Available**
114 Non-ASCE Meetings
114 Positions Announced
116 Applications for Admission
122 Men and Jobs Available
130 Equipment, Materials, and Methods
137 Films Available
138 From the Manufacturers
144 Index to Advertisers

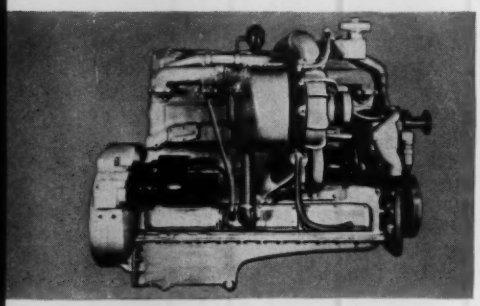
Introducing the NEW International®

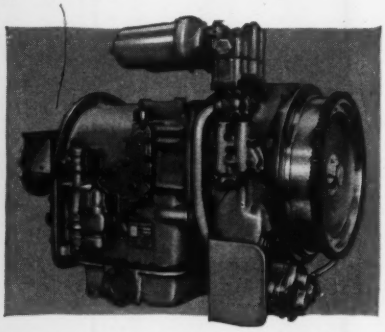
MODEL 65 18 tons MODEL 95 24 tons

Designed with the features you asked for

Hundreds of contractors, mine owners, quarry operators, and other equipment users told our engineers what they needed in an off-highway hauler. Their suggested design features have been carefully built into the new International Payhaulers. In these rugged, all-new, rear-dump haulers, you have greater horsepower-to-payload weight ratios than are available in most other off-highway trucks. You have stronger main frames to carry bigger payloads with rugged dependability. You have higher hauling speeds . . . full-power hoists for faster dumping . . . better all-around visibility.

These features are the result of rigorous, field testing. Payhaulers have worked on many contracting, mine, quarry, and similar jobs. Others have run "round-the-clock" at our proving grounds. Others have undergone painstaking laboratory research. Now all this testing is completed and the Payhaulers are ready to roll. You owe it to yourself to check their features. Our test users did—and, as proof of outstanding Payhauler performance, a great many have placed their orders. Compare Payhaulers with your present hauling units to see what profit-making features you will get.

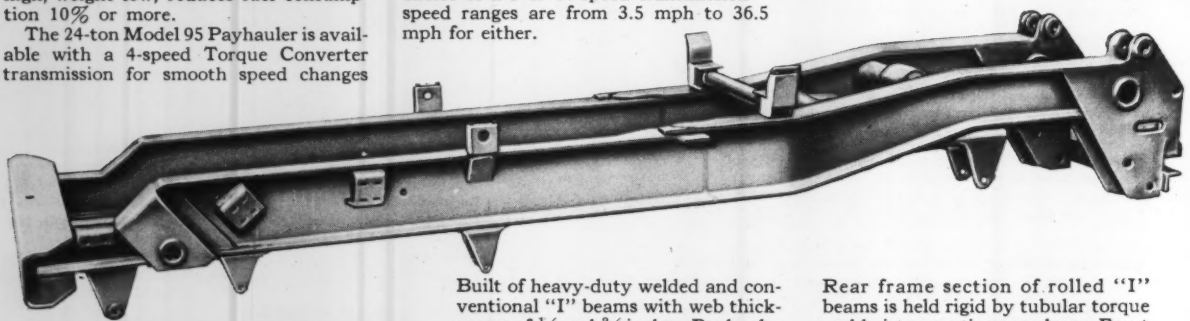




TURBO-CHARGED DIESEL ENGINES—CHOICE OF TRANSMISSIONS—Both the "65" and "95" Payhaulers have more horsepower per truck yard than any other truck in their size classes. The 24-ton, 16-yard "95" is powered by a 335 hp diesel...the 18-ton, 12-yard "65" is powered by 250 hp. Turbo-charging keeps power high, weight low, reduces fuel consumption 10% or more.

The 24-ton Model 95 Payhauler is available with a 4-speed Torque Converter transmission for smooth speed changes from 4.8 to 38 mph. A lock-up clutch for direct drive performance and a Torqmatic brake system are standard with the Torqmatic transmission. Also available for the "95" Payhauler is a 9-speed transmission which provides an excellent range of speeds from 2.6 to 37.2.

In the Model 65 Payhauler you have a choice of a 5 or 10-speed transmission—speed ranges are from 3.5 mph to 36.5 mph for either.



RUGGED, ALL-WELDED FRAME STRONGEST AVAILABLE—

Built of heavy-duty welded and conventional "I" beams with web thicknesses of ½ and ¾ inches, Payhauler main frames have the strongest known section modulus of *any* off-highway truck.

Rear frame section of rolled "I" beams is held rigid by tubular torque and hoist mounting members. Front frame members flex with shock loads through channel bumper torque member.

Payhaulers®

- 250-335 HP Turbo-Charged Diesel Engines
- Rugged All-Welded Steel Frame
- Full-Floating Axles Planetary Drive
- Speeds to 38 MPH
- Power Shift Transmission

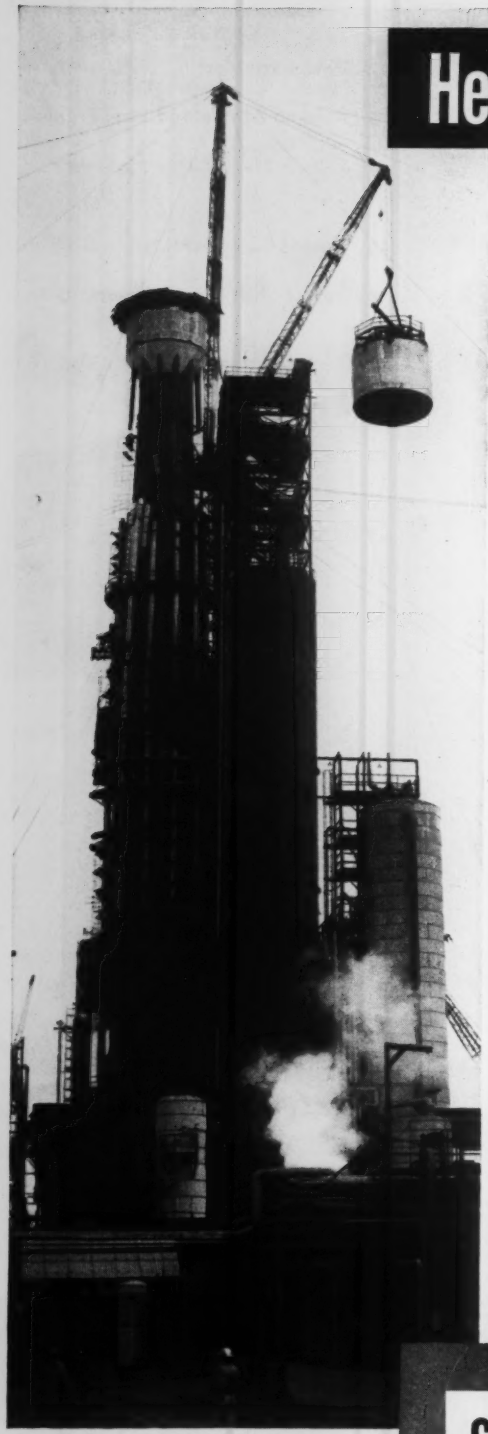
ALL WELDED ROCK-RUGGED BODIES—The Model 95 Payhauler shown is equipped with heated body. Quarry bodies available for both the Model 65 and 95 Payhaulers.

INTERNATIONAL HARVESTER

INTERNATIONAL® Construction Equipment

International Harvester Company, 180 N. Michigan Avenue, Chicago 1, Illinois

A COMPLETE POWER PACKAGE INCLUDING: Crawler, Wheel, and Pipe-Beam Tractors . . . Self-Propelled Scrapers and Bottom-Dumps . . . Crawler and Rubber-Tired Loaders . . . Off-Highway Trucks . . . Diesel and Carbureted Engines . . . Motor Trucks



360-ft. high Houdriflow unit at Marcus Hook during erection. It is one of two Houdriflow units fabricated at our Greenville and Birmingham plants through the Catalytic Construction Company for Sun Oil Company's Marcus Hook, Penn., and Toledo, Ohio, Refineries.

Here's How CB&I Solved Tough Erection Problems on 360 ft. High Houdriflow Units

Many problems confronted Chicago Bridge & Iron Company during the erection of two Houdriflow units that they fabricated and erected for the Sun Oil Company's Toledo and Marcus Hook refineries. One was the lifting of 94-ton cooling coil sections 300 feet in the air. This was handled by derricks mounted on top of 283-ft. towers designed and built by CB&I especially for these jobs.

FIELD STRESS RELIEVING

Field stress relieving was an important problem that was successfully solved. Furnaces were built at Marcus Hook and Toledo to stress relieve 13 sections with internal and external heads, for each Houdriflow unit. The 70-ft. long reactor sections were stress relieved *in place* with 20-ton hot air furnaces mounted on the stair towers . . . *approximately 160 feet in the air.*

FIELD X-RAYING

All the main seams in the reactor and regenerator, some of which were 2⅜-in. thick, were 100 per cent X-rayed in the field.

When planning steel plate structures let CB&I experience and craftsmanship work for you. Write our nearest office for additional information.

We wish to take this opportunity to pay tribute to Civil Engineering on the occasion of its twenty-fifth anniversary . . . for faithful service to a profession we both have served.

Chicago Bridge & Iron Company

Atlanta • Birmingham • Boston • Chicago • Cleveland • Detroit • Houston
Los Angeles • New York • Philadelphia • Pittsburgh • Salt Lake City
San Francisco • Seattle • Tulsa
Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY and GREENVILLE, PA.

GIANT gravity-defying sentinels of high strength alloys, armed with nuclear weapons, may be able to hover near centers of aggression ready at an instant's notice to drop destruction that will make war too deadly to risk.

100 years from now...

WE MAY MAKE WAR IMPOSSIBLE!

Scientists, looking ahead, envisage a fabulous future... full of wonderful new products that will bring civilization a whole new era of progress. But, even then, our gas and water will still flow through the same dependable cast iron pipe being laid now.

Here's proof! Today, more than 60 American cities and towns are being efficiently served by the same cast iron water and gas mains laid over 100 years ago. What's more, modernized cast iron pipe... centrifugally cast and quality-controlled ...is even stronger, tougher, more serviceable.

U. S. Pipe is proud to be one of the leaders in a forward-looking industry whose service to the world is measured in centuries.

U.S. PIPE

CAST IRON

U. S. PIPE AND FOUNDRY COMPANY, General Office: Birmingham 2, Alabama

A WHOLLY INTEGRATED PRODUCER FROM MINES AND BLAST FURNACES TO FINISHED PIPE.

First Step in Erecting Roadway Steel for New Bridge Over the Delaware

These Bethlehem bridgemen, working high above the Delaware River, are completing the first panel of roadway steel for the Philadelphia-to-Gloucester, N. J., suspension bridge.

They are shown here placing a truss-type floor beam between two open-webbed stiffening trusses. These mighty trusses run the entire length of the roadway, 3,770 ft between anchorages. Total weight of the roadway steel will be 11,700 tons.

The completed roadway will provide seven traffic lanes. Its clearance of 150 ft above mean high water at the center permits the passage of large vessels.

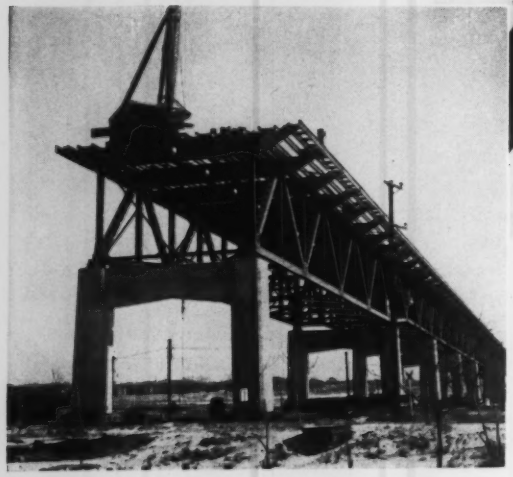
The $90,000,000 bridge, a project of the Delaware River Port Authority, will have a main span of 2,000 ft tower-to-tower, making it the eighth longest yet built. Engineers: Modjeski & Masters — Ammann & Whitney.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

▲ Erection of the first panel of roadway steelwork will be followed by setting up of a 16-ton traveler. This traveler will erect the remaining panels upon completion of the suspension cables and suspenders.



◀ In addition to the roadway and towers, Bethlehem is fabricating and erecting both approaches to the bridge. A section of the New Jersey approach is shown at left.

BETHLEHEM STEEL

HERE IT IS ... *the New* MADSEN HOT ROD

ASPHALT PLANT

An Outstanding Batch Plant in the 3000-lb., 4000-lb., 5000-lb. Capacity Range

Designed Specifically for Today's Fast-Moving Asphalt Paving Industry

MADSEN *Equipment that Serves*

Big *NEW* Features

- New fully-enclosed gear box reduction unit that goes right into the mixer shafts! . . . eliminates exposed mixer timing gears. Another MADSEN *"first."*
- Famous MADSEN Twin-Shaft Pug Mill Mixer (Patented) with externally removable sectional liners, improved mixing action and faster discharge.
- Simplest, cleanest design in the industry . . . with a minimum of removable parts for easy transport and fast set up.
- Exclusive bin design (Pat. Pend.) eliminates segregation.
- MADSEN Asphalt Pressure Injection System (Patented) with new rotating distribution bar . . . injects the asphalt into the mill quickly — cuts it off sharply to give you improved mixing and reduced mixing time.
- Fast air operation of bin gates, asphalt pressure injection and mixer gate.
- Operator's station on end of plant . . . with swivel-head asphalt and aggregate scales and all controls conveniently located for easy, fatigue-free plant operation.

MADSEN DOES IT AGAIN!

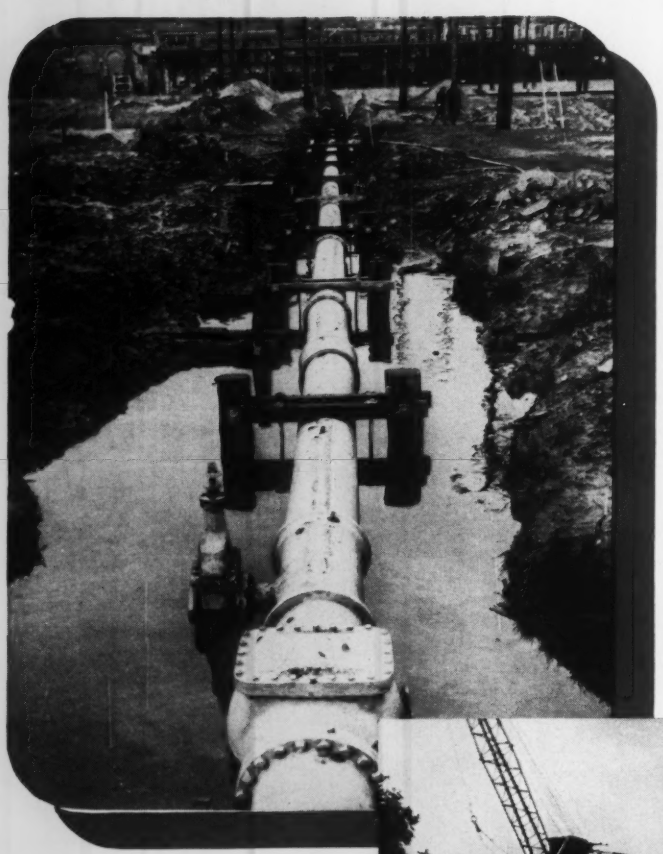
Throughout the years MADSEN has given the industry many "firsts" in asphalt plant design. And now, MADSEN announces the HOT ROD Model 391 . . . a brand-new asphalt plant that combines the best of these MADSEN-design features with revolutionary new engineering advantages. Streamlined in design. Simple in operation. The HOT ROD is keyed to today's fast-moving industry. It's a plant you can pick up and move quickly and economically. Yet, it's perfect for the "get-set-and-stay-there" type of contractor . . . and the municipality. It settles-in fast to produce maximum tonnage of top grade bituminous production. The above plant, a 5000-lb. batch capacity unit, has shown an ability to produce in excess of 200 T.P.H. at a highly consistent rate. A few highlights on this great new plant are listed at the left. You will want *all* of the facts before you buy your next asphalt plant. Contact your local MADSEN Distributor for complete details or write for Catalog No. 391 . . . MADSEN WORKS, 14120 E. ROSECRANS AVE., P. O. BOX 38, LA MIRADA, CALIFORNIA.

ASPHALT PAVING PLANTS • PUG MILL MIXERS • AGGREGATE DRYERS • DUST COLLECTOR UNITS
ROAD PUG TRAVEL-MIX PLANTS • WEIGH BATCHERS • SUPER FLOAT AND JOHNSON FLOAT FINISHERS
ASPHALT TANKS • ROYAL CROWN PUMP VALVES • ASPHALT AND FUEL PUMP UNITS

BALDWIN BLH LIMA-HAMILTON

MADSEN WORKS
CONSTRUCTION EQUIPMENT DIVISION
BALDWIN-LIMA-HAMILTON
DIVISIONS: Austin-Western • Eddystone • Electronics & Instrumentation • Hamilton • Lima • Loewy-Hydropress • Madsen • Pelton • Standard Steel Works

You can bank on it for jobs



20" Mechanical Joint Water Feeder Main installed at Atlantic City, N. J.

About 14 miles of 16" Mechanical Joint pipe installed for supply line for water district in South Carolina.

When your reputation is at stake... when the public deserves and should get dependable service... play safe by installing cast iron pipe. Through our consistent program of national advertising, the public knows that cast iron pipe serves for centuries—is reliable and economical. Today, *modernized* cast iron pipe, centrifugally cast, is even tougher, stronger and more uniform in quality than the pipe our industry made a century ago. For further information, write Cast Iron Pipe Research Association, Thos. F. Wolfe, Managing Director, 122 So. Michigan Avenue, Chicago 3.

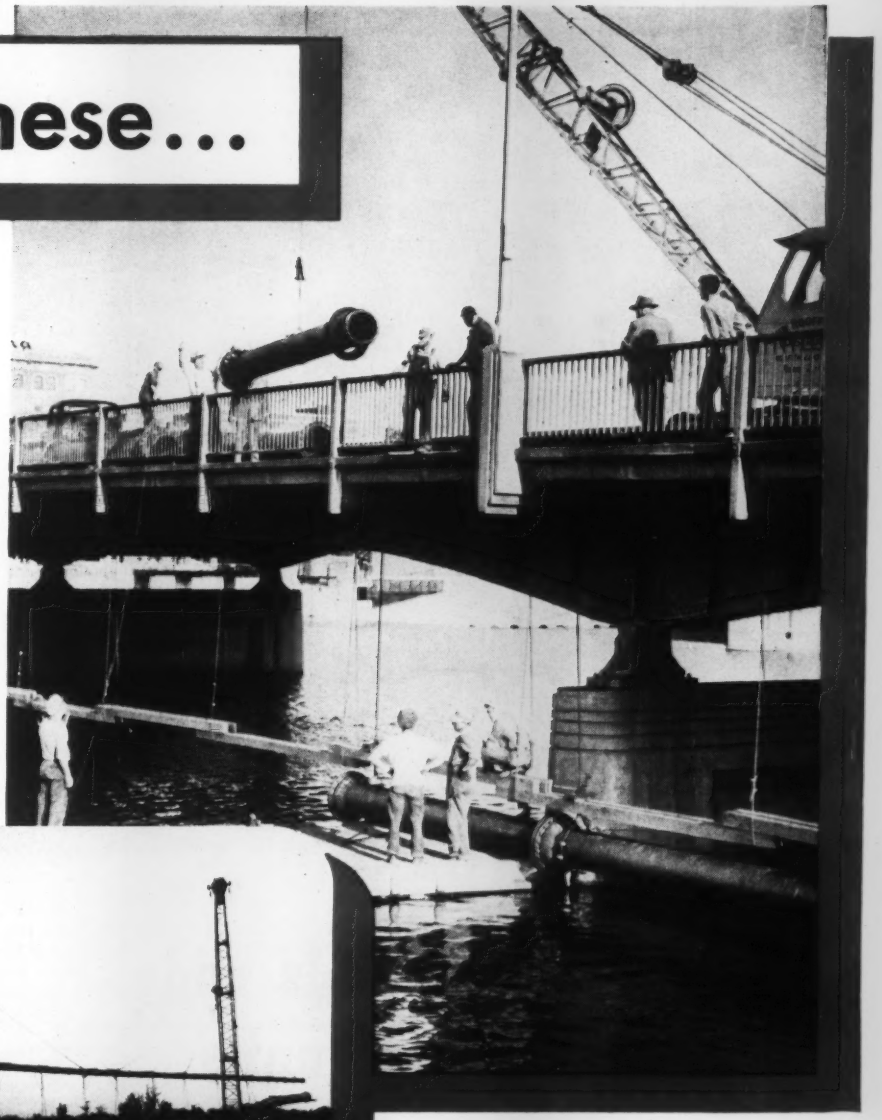
CAST Q IRON ®

The Q-Check stencilled on pipe is the Registered Service Mark of the Cast Iron Pipe Research Association.

Nearly two miles of 6" to 20" cast iron pipe for potable, process, and fire protection water systems and sewer system for petrochemical plant in Tuscola, Illinois.

CAST IRON PIPE

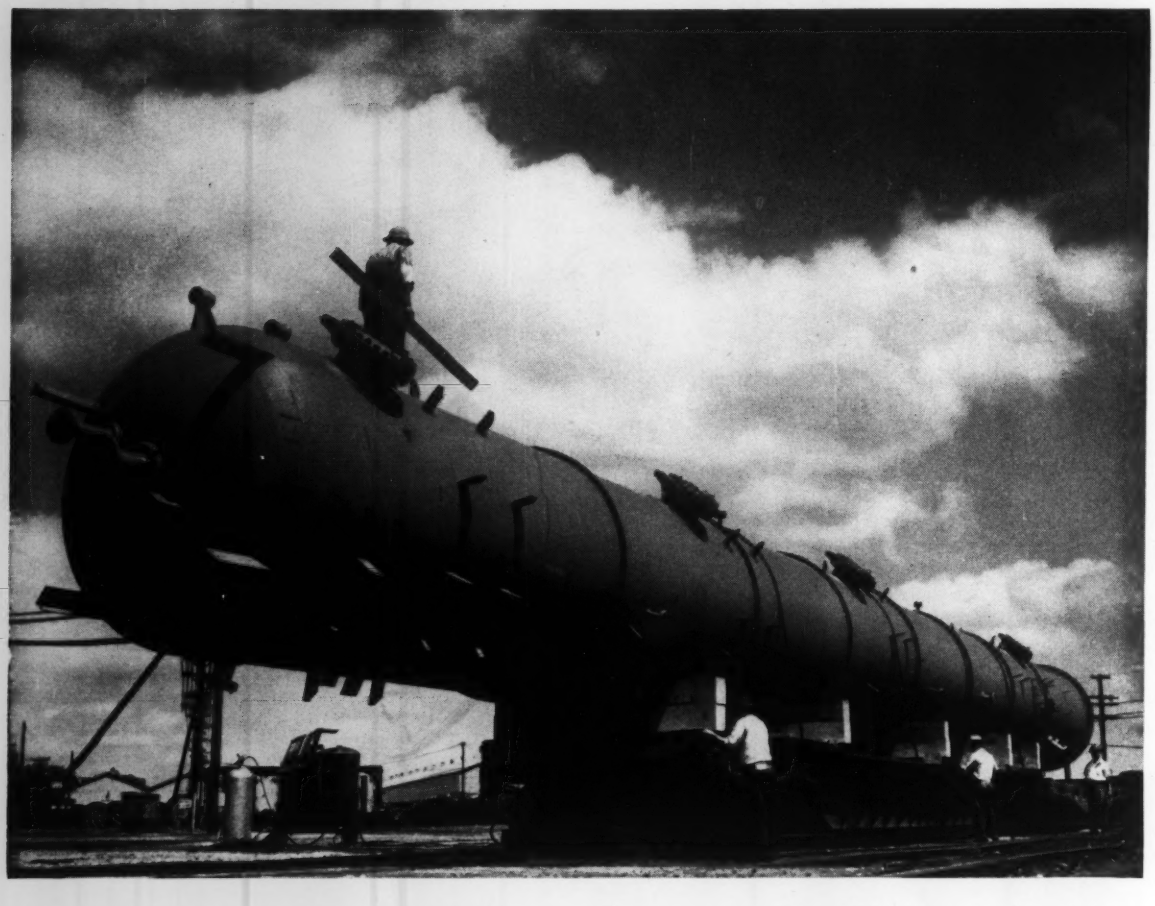
like these...



Flexible Joint cast iron pipe being laid across 600 feet-wide river at Waterloo, Iowa, for feeder line operating under 85 psi water pressure.

Installing 24-inch Flexible Joint cast iron pipe for river crossing at Fort Lauderdale, Florida.

SERVES FOR CENTURIES...



The 110'6" debutanizer shown above and the 150-ton unit (below), a 3-stage axial flow compressor, are typical Newport News products. Whether you need a hydraulic turbine, vacuum tanks or penstocks . . . bridge caissons, digesters or dryer rolls . . . you can command the services of Newport News for units of about any size or shape.

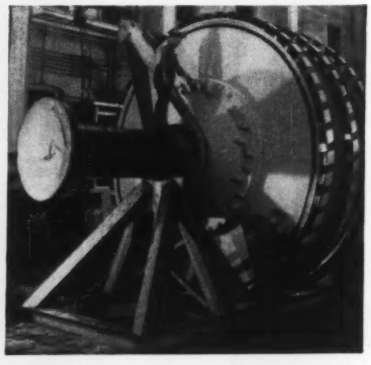
Newport News builds wide variety of large units

ALMOST ANY TYPE of heavy equipment can be built by Newport News.

And the reason? Specialized production techniques for one thing. You get the benefit of plant methods and equipment developed as a result of Newport News' seven decades of experience. Seven decades fabricating millions of tons of steel . . . carbon, corrosion-resistant alloy, clad and other special steels.

Moreover, Newport News' plant provides unsurpassed facilities. More than 225 acres in area, it comprises vast steel fabricating shops, five huge machine shops, acres of pattern shops and foundries. It includes forge and die shops, heat treating furnaces and allied equipment, along with complete modern test apparatus.

But most important of all . . . it is the high integration of skill and production facilities that enables Newport News to build large units fast . . . to save valuable time. Let us bid on your present or future projects. Write today for your copy of our illustrated booklet "Facilities and Products."



Engineers — Desirable positions available at Newport News for Designers and Engineers in many categories. Address inquiries to Employment Manager.

Newport News

Shipbuilding and Dry Dock Company
Newport News, Virginia

AMBRIDGE *Standard* STEEL JOISTS

Available Now!

IMMEDIATE DELIVERY

USS AMBRIDGE *Standard* Steel Joists provide rigid, economical and light-weight construction suitable for any type of floor, roof and ceiling. The underslung and open web design provides for maximum head room and allows passage of pipes, ducts and conduits in any direction.

In floor construction, the ease and simplicity of handling this new-design steel joist reduces installation time to a minimum and permits other trades to begin work promptly. And for roof construction, AMBRIDGE Steel Joists cut the time required to put structure under cover.

AMBRIDGE Steel Joists are fabricated and assembled on a modern production line basis to assure you a *better* product in *faster* time, thus enabling you to build an economical structure without interruption of your schedule. *Your joists are ready when you are ready for them.*

ASK FOR FREE BOOKLET: For detailed information about the time-and-money-saving advantages of using AMBRIDGE Steel Joists on your next job, get in touch with our nearest Contracting Office, or write direct to Pittsburgh for a free copy of our 36-page catalog.

INTERESTING MOTION PICTURES AVAILABLE—"Building for the Nations" and "The Suspension Bridge," two entertaining and educational films, are now available without charge to business, fraternal and civic organizations, churches, schools and colleges. Write to Pittsburgh office for bookings.

AMERICAN BRIDGE DIVISION, UNITED STATES STEEL CORPORATION, GENERAL OFFICES: 525 WILLIAM PENN PLACE, PITTSBURGH, PA.

Contracting Offices in: AMBRIDGE • ATLANTA • BALTIMORE • BIRMINGHAM • BOSTON • CHICAGO • CINCINNATI • CLEVELAND • DALLAS • DENVER • DETROIT • ELMIRA • GARY HOUSTON • LOS ANGELES • MEMPHIS • MINNEAPOLIS • NEW YORK • ORANGE, TEXAS • PHILADELPHIA • PITTSBURGH • PORTLAND, ORE. • ROANOKE • ST. LOUIS • SAN FRANCISCO • TRENTON

UNITED STATES STEEL EXPORT COMPANY, NEW YORK

AMBRIDGE STEEL JOISTS

USS

UNITED STATES STEEL

LINK-BELT PRE-BILT

MADE NEAR YOU

Built in standard sections for 18, 24, 30 and 36-in. belt widths... at each of 9 plants

AN unmatched combination of belt conveyor efficiency and economy, Link-Belt PRE-BILT sectional belt conveyors incorporate standard products packaged with standardized sectional truss frames and structural steel supporting bents. They're easy to install . . . require little or no special engineering on most jobs. And their portability plus easy extension are important aids to flexibility.

PRE-BILT conveyors are manufactured at a Link-Belt plant in your own area to assure prompt delivery. There are also Link-Belt sales offices located throughout the country . . . equipped to give you prompt, efficient service for all your belt conveyor requirements.

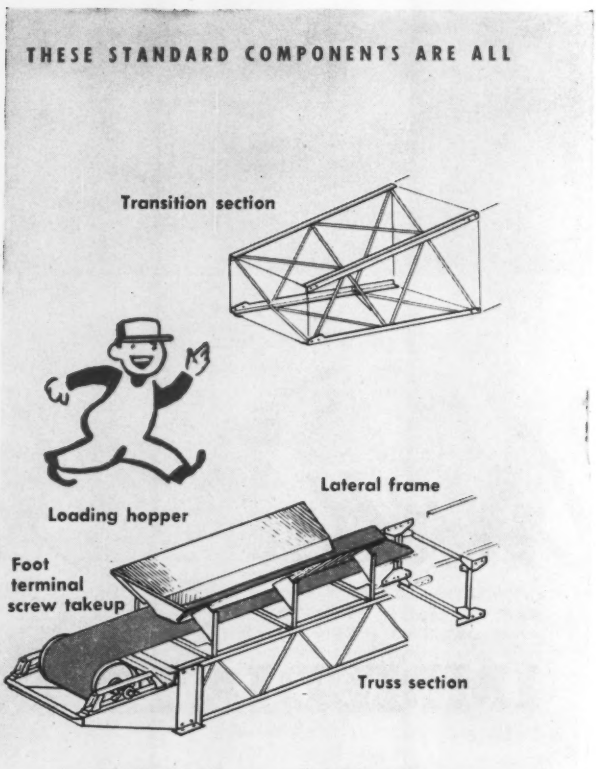
For more information about these conveyors—with drives up to 40 hp and 24 and 42-inch truss depths, write for your copy of Book No. 2579.

LINK-BELT

BELT CONVEYOR EQUIPMENT

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.

14,110



AS SIMPLE AS THIS FROM SELECTION TO OPERATION —

EASY SELECTION
Your Link-Belt representative will help you select the best combination of PRE-BILT sectional belt conveyor components.

PROMPT QUOTATIONS
He will prepare a comprehensive and accurate estimate of requirements for installations that permit "on-the-ground" survey.

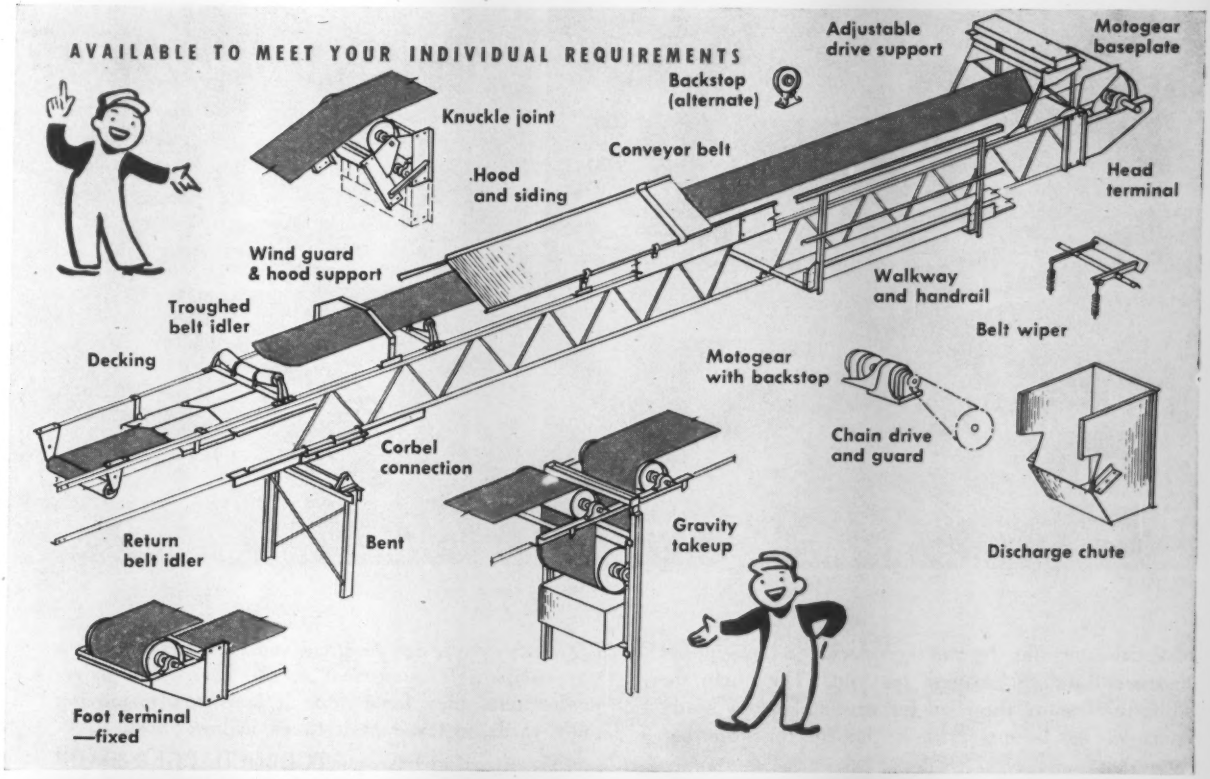
SIMPLIFIED PURCHASE
Parts are standardized, interchangeable, all available from one supplier. Link-Belt representative can furnish all necessary data.

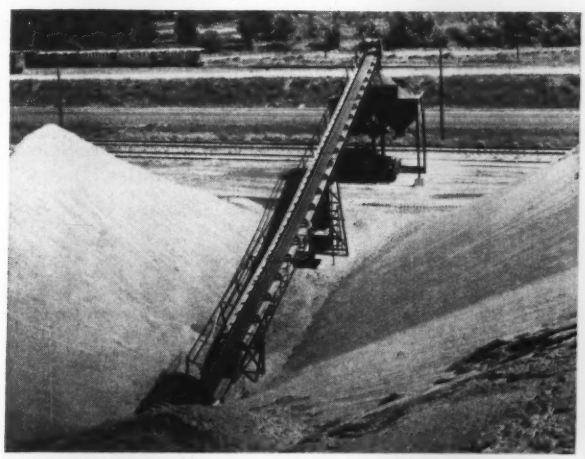
QUICK DELIVERY
PRE-BILT conveyors are built at nine strategic locations and are shipped from the plant nearest you.

FAST INSTALLATION
Can be readily handled by your own erectors in most cases—due to simple construction and shop-assembled components. Link-Belt can also furnish complete erection service and supervision.

Sectional Belt Conveyors

FOR FAST DELIVERY





PRE-BILT reclaim belt conveyor delivers sand and gravel from tunnel under stockpile to hopper. System of nine belt conveyors and two radial stackers handles up to 6000 tons per day.

PRE-BILT conveyors can be easily extended to follow mining or disposal operations, as in this system providing low-cost disposal for 1140 long tons per hour of overburden and lean ore.

SHAPING TOMORROW'S OPPORTUNITIES

Advertisements like the one reproduced on the opposite page are building business for you. They help the public understand the need for new and better roads. Caterpillar has been working at that job for more than seven years.

Motorists and taxpayers want good highways today, and are ready to pay for them. Getting them built is *your job*. And here again Caterpillar is able to help. When your bid gets the contract, the equipment you use can make the difference between profit and loss. Caterpillar research, constantly developing and improving engines and earthmoving machines, is giving you greater production, lower operating costs, surer profits.

Take the new Caterpillar wheeled rigs as an example. The CAT* DW21 Tractor (Series C) and the DW20 Tractor (Series E), with their matching LOWBOWL Scrapers, are designed and built to *outperform any comparable equipment in the field.* And in repeated tests they have done it consistently, moving more yards, in faster cycle times, at lower cost.

These tractors have new TURBOCHARGED 300 HP (maximum output) Caterpillar Engines, and their big new wide-section tubeless tires add to flotation and traction and save on tire maintenance. The LOWBOWL construction of the scrapers permits faster loading and bigger loads with less effort.

Caterpillar—and your Caterpillar Dealer—are your partners in shaping tomorrow's opportunities.

Caterpillar Tractor Co., Peoria, Illinois, U. S. A.

CATERPILLAR*

*Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.

LEADERSHIP IN ACTION

This advertisement appeared in full color in *The Saturday Evening Post*, April 28, 1956

Beautiful Delaware Memorial Bridge, built five years ago to connect the southern end of the New Jersey Turnpike with Delaware, is the world's sixth longest single span suspension bridge. Since opened, 34 million cars have crossed it.

Delaware's proud of its big bridge but...

The millions of cars it funnels through the state were giving Tom Gray fits as he tried to drive to work. Problem sound familiar? Here's what one state intends to do about it.

In New Castle, Del., Tom Gray's civic pride in his state's most ambitious project—the Delaware Memorial Bridge—wasn't all that it might be. He felt that, while driving to work in Wilmington, he personally encountered every one of the 8 million cars which use the bridge annually.

This sudden deluge of through traffic was bringing new problems to the state's already overburdened road system. Tom was painfully aware that Maryland, Pennsylvania and New Jersey aimed main highways at his state. He knew, too, that Delaware's population and car registration was the fastest growing east of the Mississippi. As a result, traffic on the roads he used to drive to work increased 13% each year since 1950!

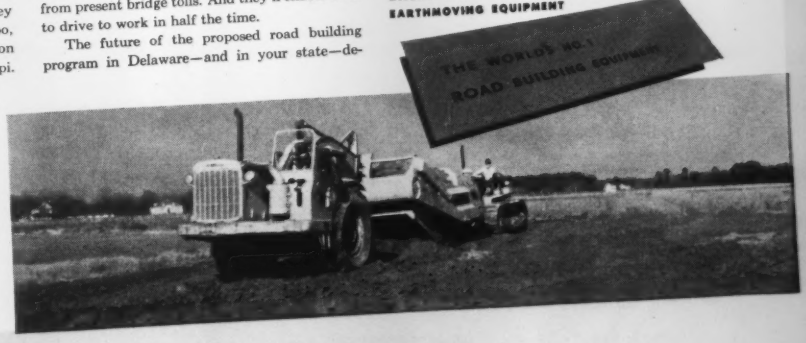
Now the state of Delaware is acting. It proposes a progressive $325 million 15-year road building program. Of this amount, $112 million is scheduled for two-, four- and six-lane arterial highways across the state. These limited-access roads, designed to speed bridge traffic without tying up local roads, are expected to be built from present bridge tolls. And they'll enable Tom to drive to work in half the time.

The future of the proposed road building program in Delaware—and in your state—depends on voters making their support known. And if *you* want to know what you can do to put across *your* state's highway program, write today for free booklet, "Road Block." Just mail a card to Dept. 4, Caterpillar Tractor Co., Peoria, Illinois, U. S. A.

CATERPILLAR

Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.

DIESEL ENGINES • TRACTORS • MOTOR GRADERS
EARTHMOVING EQUIPMENT

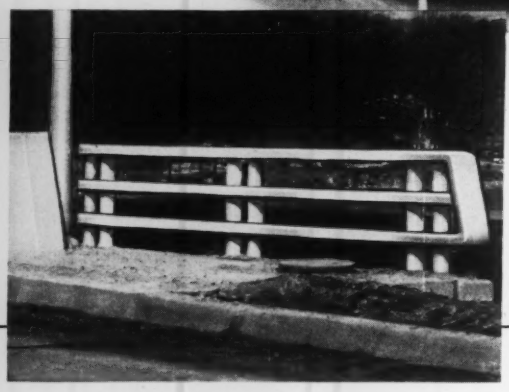


Wherever you see Caterpillar machines working on your roads, you can be sure your state is getting its money's worth.

Delaware Highway Week is being celebrated April 23 to 30 in conjunction with Springtime in Delaware. All state highway installations are opened for inspection.

THE MODERN PATTERN IN RAILINGS AND LIGHTING STANDARDS...

aluminum



Reynolds Aluminum Guard Rails on the A. E. Staley Bridge on Route 36 in Decatur, Illinois.

Contractor and Erector:
M. J. Boyle & Company,
Chicago, Illinois.

Fabricator:
Commercial Shearing and Stampings Inc.,
Chicago, Illinois.

Engineers:
Illinois State Highway Department.

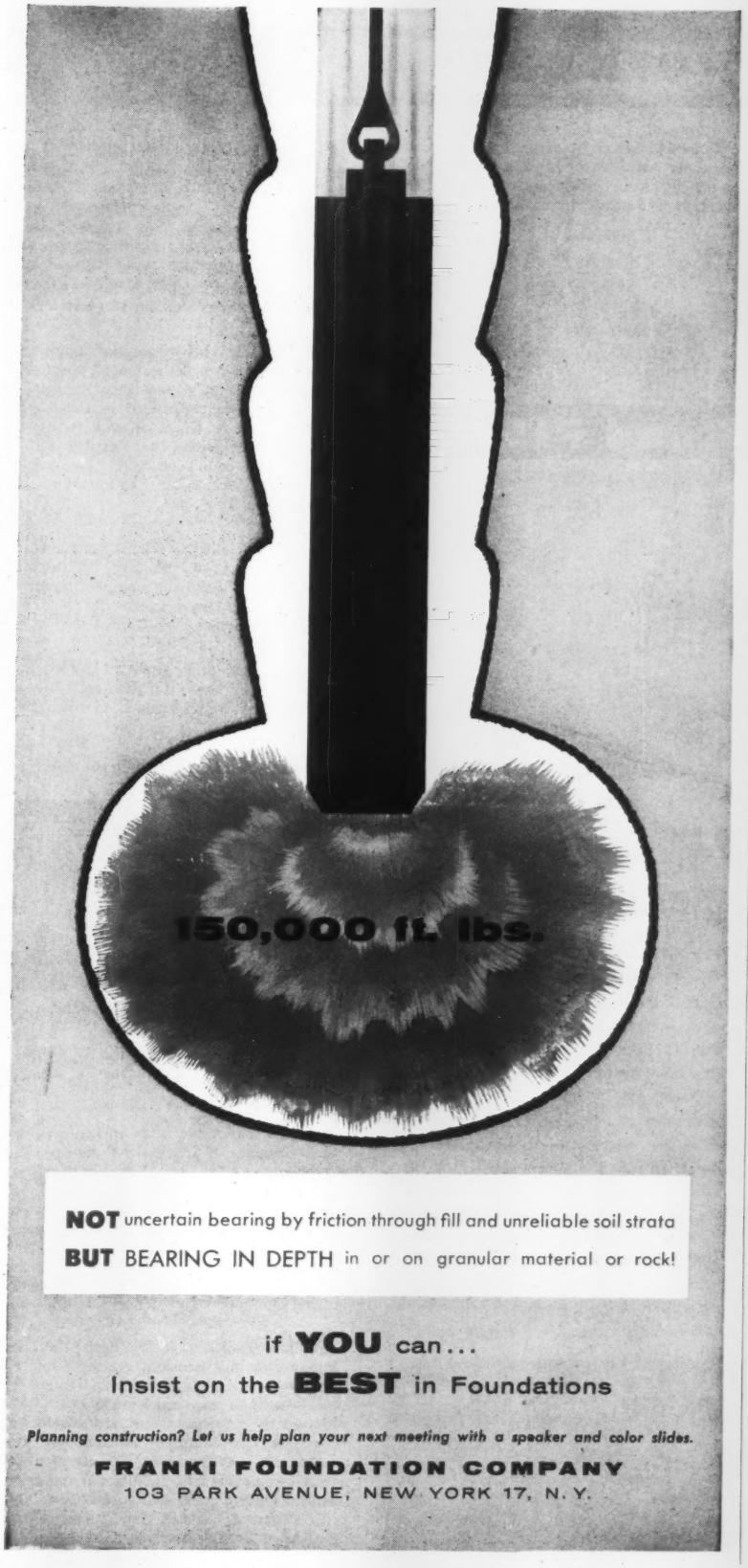
On more and more bridges and viaducts across the country, guard rails and lighting standards attest the beauty of modern design with aluminum. The pattern has become traditional...aluminum for strength, for rustproof permanence without painting, for lower installed cost due to lighter weight and better workability.

In the example shown here, railings and posts are specially cast aluminum. Many other guard rails use standard shapes and tubings. Illustrated booklet on request. For either standard mill products or for special requirements, call the nearest Reynolds Office listed under "Aluminum" in classified directories. Or write to **Reynolds Metals Company,** General Sales Office, Louisville 1, Kentucky.

For quick reference, see catalog $\frac{5a}{Re}$ *in Sweet's Architectural File.*

REYNOLDS ALUMINUM

See "FRONTIER", Reynolds great dramatic series, Sundays, NBC-TV Network.

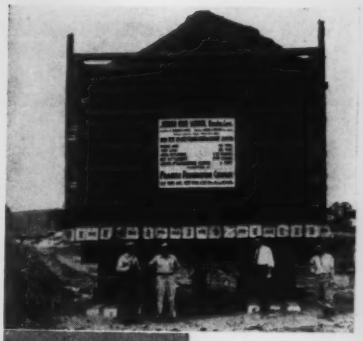


NOT uncertain bearing by friction through fill and unreliable soil strata
BUT BEARING IN DEPTH in or on granular material or rock!

if **YOU** can...
Insist on the **BEST** in Foundations

Planning construction? Let us help plan your next meeting with a speaker and color slides.

FRANKI FOUNDATION COMPANY
103 PARK AVENUE, NEW YORK 17, N.Y.



FRANKI FACTS

When the Junior High School Building for the City of Hamden, Connecticut, was planned, the type of foundation specified was cast-in-place concrete piles. After a thorough investigation of the Franki method, the foundation design was changed to Franki Displacement Caissons by the Architect, Mr. William H. Ashley, and the Consulting Engineer, Arthur G. Beaulieu Associates.

A total of 209 Displacement Caissons were forged into the ground with blows of 150,000 foot pounds by the Franki method. The caissons had a nominal shaft diameter of 22″ and were driven 10 to 37′ deep into fine to medium sand. When tested under a load of 210 tons, 50% greater than the maximum design load of 140 tons for the caisson, one of these Franki Displacement Caissons showed a net settlement of slightly in excess of $\frac{1}{16}$″ (actually $\frac{5}{64}$″).

The change in design from cast-in-place concrete piles to Franki Displacement Caissons resulted in a saving of over $23,000 in the foundation construction cost. The Fusco-Amatruda Company was the General Contractor on this project.

LITERATURE AVAILABLE

Brochure describing various Franki Foundation methods will be furnished on request. Write to:

Franki Foundation Company
103 Park Avenue
New York 17, New York

NEWS OF ENGINEERS

Mark D. Hollis, assistant surgeon general and chief engineer of the U. S. Public Health Service, was awarded the honorary doctor of science degree by the University of Florida at the mid-year commencement exercises. Mr. Hollis also was principal commencement speaker, addressing the graduates on the subject of "Advancing Technology."

Chicago Bridge & Iron Company announces the election of **Horace B. Horton** as chairman of the board; **Ernest E. Michaels,** formerly executive vice-president, as president; and **Charles S. Pillsbury,** formerly vice-president and treasurer, as vice-president and secretary.

Alfred C. Ingersoll, assistant professor of civil engineering at the California Institute of Technology, has been elected national president of Chi Epsilon, engineering honor fraternity. Dr. Ingersoll, a graduate of the University of Wisconsin, where he received his M. S. and Ph. D. degrees has been a Caltech faculty member since 1950. He has been secretary-treasurer of Chi Epsilon since 1942.

Kenneth C. Cox, since 1953 chief engineer of Dravo of Canada Limited, has been elected a member of the board of directors. He has served the Dravo Corporation, Pittsburgh, in various engineering capacities for more than 13 years.

Roy M. Harris, chief sanitary engineer for the Creole Petroleum Corp., Caracas, Venezuela, recently received his commission as a Rear Admiral in the Civil Engineer Corps, U. S. Naval Reserve. Admiral Harris joined the Naval Reserve in 1936. He has been with the Creole Petroleum Corp. with headquarters in Caracas since 1946.

Charles H. Sells has taken over the consulting practice of the late **A. Burton Cohen.** The consulting engineering firm will be Chas. H. Sells, Inc., with offices at 70 East 45th Street, New York City.

Leeds, Hill and Jewett, Consulting Engineers, announce the removal of their office to 609 South Grand Avenue, Los Angeles 17, Calif.

James A. Mandigo has been promoted to director of facilities for the Trans World Airlines passenger service department. In this capacity he will have the responsibility of providing airport terminal facilities for TWA passengers at all stations on the airline's world routes. Mr. Mandigo has been with TWA since 1946, and prior to his promotion was a functional engineer in the construction department.

J. A. Mandigo

John A. Bader has been appointed chief sales engineer of Intrusion-Prepakt, Inc., Cleveland, Ohio. Mr. Bader will supervise the expanded sales activity of the company in this newly created position. Previously he was manager of the company's construction department, Eastern Division, and was responsible for the construction and installation of drainage systems.

William J. Miller, Jr., has been promoted from traffic and planning engineer for the Delaware State Highway Department to the post of deputy chief engineer. Other changes in the department include the advancement of **Chauncey O. Simpson** from surburban development engineer to research engineer, with additional duties as federal aid engineer. **R. A. Haber** is new chief engineer of the department, effective April 1 (May issue, page 23).

FOR BRIDGES and PIERS

BEFORE DRI-POR

AFTER DRI-POR

How DRI-POR® reduces your Pile-Repair Costs:

Lasting repair of bridge or pier piling eroded in the tidal range is now a routine procedure using the "DRI-POR" system of pile encasement.

The "DRI-POR" system utilizes a patented "K Box" which allows the repair of damaged piles below the water line "in the dry". This results in the following advantages not enjoyed by any other existing procedure.

- Removal of all decayed concrete
- Welding of replaced reinforcing
- No contamination of pile repair
- No expensive diving procedures
- Leak proof, watertight forms
- No tremie or grouting required
- Visual inspection by inspector
- Control of repair at all times

In addition, "DRI-POR" admixtures and low water-cement ratios increase density, impermeability and frost and chemical resistance of the concrete encasement.

With these many advantages, initial costs are reduced and life of repair lengthened. In other words, "DRI-POR" gives you the best repair at lowest cost. If you have a pile repair problem, it will pay you to learn more about "DRI-POR." Write for information, specifications and a pamphlet describing the repair of the 5 mile long *James River Bridge System.*

DRI-POR

DRI-POR SYSTEMS

An exclusive process of

MASONRY RESURFACING AND CONSTRUCTION CO. INC.

BALTIMORE 26, MD.

Brother B. Austin Barry, assistant professor of civil engineering at Manhattan College, has been elected a director of the Education Division of the American Congress on Surveying and Mapping.

Harold I. Howell has been promoted to chief system project engineer of the Niagara-Mohawk Power Corporation's System Project Engineering Department in Buffalo, N.Y. He will be responsible for all major generating developments in the state-wide Niagara-Mohawk System. Mr. Howell has been with the company since 1926.

Michael Fiegen has been made an associate in the New York City consulting firm of Ammann & Whitney. Through an inadvertence that is much regretted, Mr. Fiegen's name was omitted from the list in the May issue of other ASCE members recently admitted to the firm.

Carl Wayland Capwell, recently promoted to Commander, Civil Engineer Corps of the Navy, is now stationed at Pearl Harbor, Hawaii. His address is Naval Shipyard, Navy No. 128, APO, San Francisco, Calif.

William Little, Jr., Plainfield, N.J., serving with the 86th Engineer Construction Battalion at Fort Dix, N.J., was recently promoted to first lieutenant. He is a graduate of Virginia Polytechnic Institute, and has been in the Army since 1954.

Toltz, King and Day, Inc., architects and engineers of St. Paul, Minn., has changed its corporate name to Toltz, King, Duvall, Anderson and Associaties, Inc. **Gerald Anderson** and **Arndt Duvall,** whose names have been added, have been members of the firm for the past 25 years. **W. E. King** will continue as president of the firm which was organized in 1910 as Toltz Engineering Co. and changed to Toltz, King and Day, Inc., in 1919.

Mark K. Wilson, Jr., of the Mark K. Wilson Co., Chattanooga, Tenn., was honored recently by the American Standards Association for his contributions to the establishment of voluntary standards. As a representative of ASCE, Mr. Wilson is a member of the Standard Council, which is responsible for the technical program of the American Standards Association.

Charles W. Yoder, Milwaukee consulting engineer, and **Ned E. Fischer,** associate, announce a change in address to larger offices located at 3505 West Center Street, Milwaukee, 10, Wis.

Raymond J. Rosenberger, of Bay Village, Ohio, has been appointed chief of the Specification Division of the H. K. Ferguson Company, Cleveland, Ohio. Prior to January 1, 1956, Mr. Rosenberger was Cleveland manager for Gilbert Associates, Inc., Engineers and Consultants, of Reading, Pa.

John O. Eichler is leaving Cooper Union on June 1 to go to Georgia Institute of Technology as professor of civil engineering in charge of surveying, mapping, and photogrammetry. He will also be in charge of the summer surveying camp there. At Cooper Union he has been associate professor of civil engineering.

Ben Maccabee, of the Engineering Service Bureau, Chicago, Ill., has expanded his activities to form a partnership, Maccabee, Campbell & Associates. The firm will engage in civil engineering work for state, county, and municipal governments, and seaway and toll road authorities. The offices are at 173 E. Madison St., Chicago.

Lynn W. Pine, Colonel, Army Corps of Engineers, has assumed new duties as Garrison District Engineer at Riverdale, N. Dak. Colonel Pine, who went to North Dakota from Germany, where he was on a European assignment, succeeds **Col. Henry L. Hille, Jr.** who has been assigned to the U. S. Army Inspector General at the Pentagon in Washington. Col. Hille, has been at Garrison Dam since 1953. As of July 1 the Garrison District will be consolidated with Fort Peck, with headquarters at Riverdale.

Col. L. W. Pine

Herman H. Druebert, of New Braunfels, Tex., has been appointed deck officer in the Coast and Geodetic Survey and assigned to the Ship *Pathfinder*, with headquarters at Seattle, Wash. He will be engaged in hydrographic surveys in Alaskan waters during the coming summer. Mr. Druebert is a recent civil engineering graduate of the University of Texas.

Clyde L. Palmer, assistant chief engineer, City of Detroit, and former president of the Michigan Section, was recently elected treasurer of the Engineering Society of Detroit. He has just completed a term as assistant treasurer.

James R. Fraser has been appointed chief engineer of the H. K. Ferguson Company, industrial designers and builders of Cleveland, Ohio. Mr. Fraser has served for several years as district engineer in charge of design activities of the company's central district, with offices in Cleveland.

George C. McKinney, consulting engineer of San Jose, Calif., is touring Western Europe with a party of American consulting engineers who will visit consulting offices in London, Amsterdam, Frankfort, Zurich and Paris. The party will also visit field engineering and construction projects in and near these cities.

(*Continued on page 28*)

Here are important facts for the "man behind the gun"

This White 18" Dumpy level has

...more of the features you want, yet costs you less!

Before you buy, compare this White Dumpy level with a similar model of any other recognized make. From every standpoint — design detail . . . quality construction . . . work-speeding, life-lengthening features and cost — you'll quickly see why a White's the best buy you can make. It will make your work faster, easier, more accurate. Check this comparison chart:

FEATURES	D. White No. 7080	Instrument A	Instrument B
Magnifying power of telescope	35X	30X	27X
Distance away you can read 1/100 ft. graduation	1200 ft.	1050 ft.	900 ft.
Diameter of objective lens	1.81 in.	1.485 in.	1.69 in.
Field of view (in minutes of arc)	64′	52′	60′
Coated optics	YES	YES	YES
Covered leveling screws	YES	YES	YES
Can you easily replace worn leveling screws in the field?	YES	NO	YES
Sensitivity of level vial (in seconds of arc per 2mm of graduation)	20″	20″	25″
Price — complete with carrying case, tripod and accessories — F.O.B. factory	$315.00*	higher	higher

For complete details on the 18-in. Dumpy level and other equally fine engineering instruments, see your David White dealer, or write direct to DAVID WHITE CO., 309 W. Court Street, Milwaukee 12, Wisconsin.

DAVID WHITE COMPANY

We offer complete, expert repair service on all makes, all types of instruments.

*Price subject to change without notice.

3 WAYS TO BUILD WITH

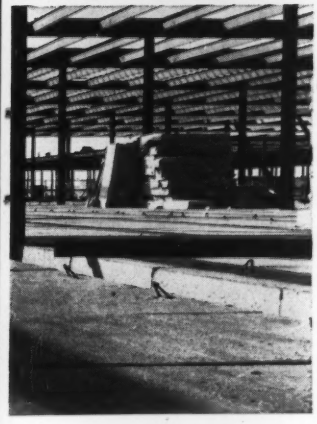
• FIRST OF ITS KIND

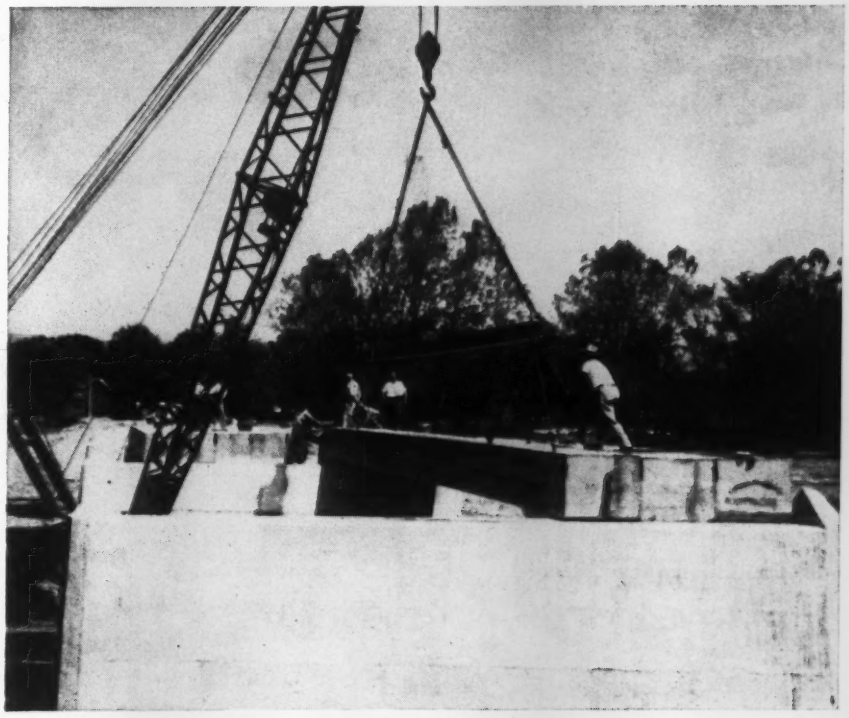
This Lincoln Tunnel Retaining Wall was designed and built by the Port of New York Authority. A maximum of 50 feet high, the wall consists of concrete piers poured in place with slots in the sides. Precast, prestressed panels are dropped into these slots to form the wall. This is the first use of this type of construction in the United States. The panels are 4 feet wide and either 12 inches or 18 inches thick. They are pretensioned to 175,000 psi, with thirty-two or forty-six $\frac{3}{8}$″ diameter American Special High Strength Stress-Relieved Strands. Panels were manufactured by Precrete, Inc., Astoria, Long Island.

• TWO MODERN IDEAS AND ONE OLD

American Welded Wire Fabric has been used for more than 30 years to reinforce all types of concrete construction. American High Strength Stress-Relieved Strand for prestressed concrete, a high-quality product developed expressly for this application, is now also being used extensively in all types of construction. A typical installation is this large shopping center at Roosevelt Field in New York, where precast welded wire fabric reinforced channel slabs combine with precast *prestressed* slabs to make a better building. The reinforced slabs, 16 feet long, use American Welded Wire Fabric, 3″ x 8″—3 gage x 8 gage. The prestressed slabs, in lengths of 27′, 31′-6″, and 33′-6″, are pretensioned with American High Strength Stress-Relieved Strand. This is a Webb & Knapp project, designed by Boehler and Bugnoni. Structural Engineers were Severud-Elstad-Krueger of New York City. Slabs were manufactured by Precrete, Inc., Astoria, Long Island.

PRESTRESSED CONCRETE





• CUTS COST

The prestressed beams for this concrete bridge in Pennsylvania cost far less than conventional built-in-place members of equivalent strength. They were pretensioned with American High Strength Stress-Relieved Strand. Prestressed concrete often saves money because it can be precast on an assembly-line basis at a factory. In addition, prestressed members take less concrete and steel because the high strength steel is stronger and does "more work" per pound used. And prestressed members can be installed more quickly.

AMERICAN STEEL & WIRE DIVISION, UNITED STATES STEEL • GENERAL OFFICES: CLEVELAND, OHIO

COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA., SOUTHERN DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

FACTS! about making concrete stronger!

American Steel & Wire
Room X-66, Rockefeller Bldg.
Cleveland 13, Ohio

Please send me complete technical data on the following products:

☐ *American Super-Tens Stress-Relieved Wire and High Strength Strand for Prestressed Concrete*
☐ *American Welded Wire Fabric Reinforcement*

Name .....

Firm .....

City ..... State .....

USS

USS AMERICAN *Super-Tens* Stress-Relieved WIRE

and

AMERICAN HIGH STRENGTH STRESS-RELIEVED STRAND

UNITED STATES STEEL

Tough Digging in Confined Areas

Eimco 105 Tractor Excavators can work efficiently in small areas because of their built in features.

These features permit the Eimco 105 to work in many places such as narrow ditch digging, tunnels, water channels, mines, railroad cuts, highway widening jobs and numerous others including basement excavation as shown above.

The Eimco 105 features include: (1) Independent track control so that one track can be run forward while the other runs reverse providing spin turns in the length of the machine, (2) Up front position of the operator for better visibility in confined areas, (3) Overhead bucket motion, to eliminate the necessity of turning to discharge the bucket, (4) Simple easy controls, two small handles are all that control the motion of the tractor. Push for forward motion and pull for reverse motion.

Eimco 105 Tractor-Excavators are being used on construction jobs all over the world as well as in mines and quarries. These machines are operating longer periods at lower cost per yard loaded than any other equipment.

Investigate the Eimco Tractor-Excavator — it is the world's finest crawler tractor equipment.

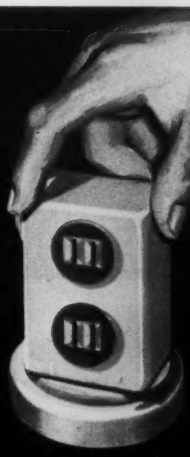
THE EIMCO CORPORATION

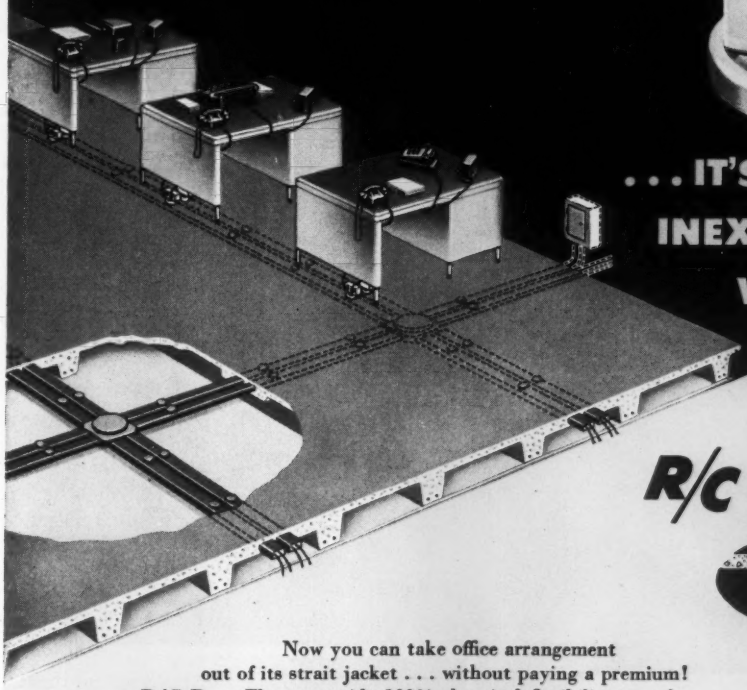
Salt Lake City, Utah—U.S.A. • Export Offices: Eimco Bldg., 52 South St., New York City

New York, N. Y. Chicago, Ill. San Francisco, Calif. El Paso, Tex. Birmingham, Ala. Duluth, Minn. Kellogg, Ida. Baltimore, Md. Pittsburgh, Pa. Seattle, Wash. Pasadena, Calif. Houston, Texas Vancouver, B. C. London, England Gateshead, England Paris, France Milan, Italy Johannesburg, South Africa

B-105

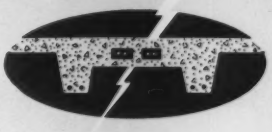
MOVE YOUR OUTLETS TO WHEREVER YOU NEED THEM!





. . . IT'S EASY AND INEXPENSIVE WITH . . . .

low cost R/C DUCT FLOORS



Now you can take office arrangement out of its strait jacket . . . without paying a premium! R/C Duct Floors provide 100% electrical flexibility to take care of any future rearrangements. Yet its original cost is about the same as a conventional wiring system of equal capacity. Outlets for power and communications systems can be connected to convenient risers in a matter of minutes. There is no ripping up or drilling through floors and ducts.

R/C Duct Floors consist of *standard* steel electrical distribution ducts set in the *structural* slab of reinforced concrete joist floors . . . *no expensive fill or topping is needed.* Meet all code requirements.

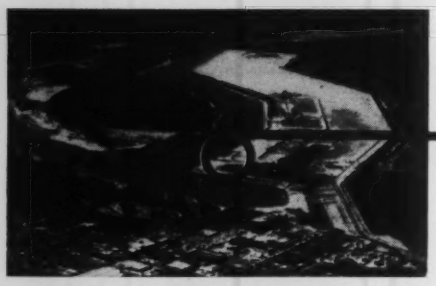
Average costs show that R/C Duct Floors cost 19% less than cellular steel floors! Before you design your next building, why not investigate R/C Duct Floors?

SEND FOR NEW 16-PAGE BULLETIN
Includes full details on design, costs, and technical specifications.

CONCRETE REINFORCING STEEL INSTITUTE
38 South Dearborn Street
Chicago 3, Illinois

ANOTHER R/C DUCT FLOOR JOB!

Ohio State Office Building, Columbus, Ohio



New Three-Way securely and

1,200 TONS OF USS

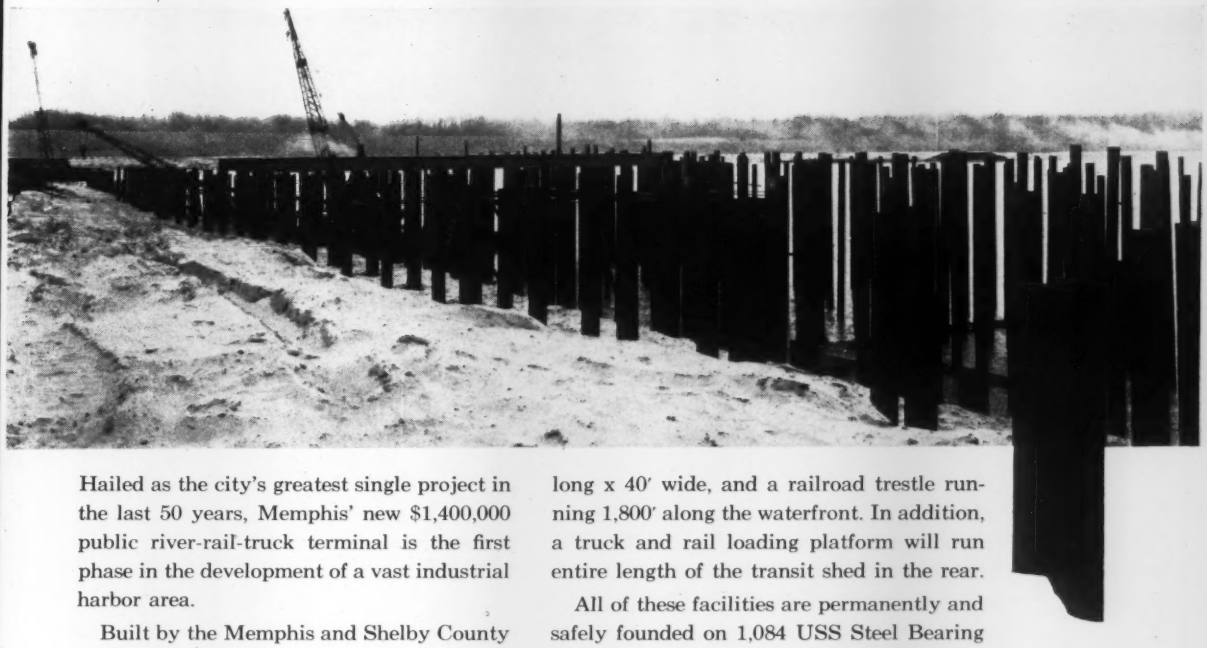
Memphis Municipal
River-Rail-Truck Terminal

Norton & Rice, Architects & Engineers
Memphis, Tennessee

Consolidated Contractors, General Contractor
Memphis, Tennessee

Harry B. Hunter & Associates, Structural Engineer
Memphis, Tennessee

Terminal at Memphis permanently built on *Steel* BEARING PILES



Hailed as the city's greatest single project in the last 50 years, Memphis' new $1,400,000 public river-rail-truck terminal is the first phase in the development of a vast industrial harbor area.

Built by the Memphis and Shelby County Port Commission, this modern terminal consists of a large transit shed containing 28 800 square feet of floor space, a paved dock, 400′ long x 40′ wide, and a railroad trestle running 1,800′ along the waterfront. In addition, a truck and rail loading platform will run entire length of the transit shed in the rear.

All of these facilities are permanently and safely founded on 1,084 USS Steel Bearing Piles varying in height from 35′ to 75′, some of which were driven to a depth of 38′.

Proved Structurally and Economically Sound

USS STEEL BEARING PILES have been proved structurally and economically sound in a wide variety of projects. On large jobs and small. In fresh water and in salt water. Under buildings, bridges, piers, docks, dams and viaducts. They can support unusually heavy loads per pile . . . and resist high bending stresses. They effectively resist lateral displacements . . . penetrate with remarkable ease through all types of unstable sub-soil materials, to provide a secure means of supporting foundations at great depth.

Their great capacity for high unit loads, both vertical and horizontal, means fewer piles and fewer driving operations for a given load. USS Steel Bearing Piles are readily handled in the field with ordinary equipment, and are easy to splice, eliminate jetting, and withstand rough handling.

UNITED STATES STEEL CORPORATION, PITTSBURGH • COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. • UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS Steel H-Bearing Piles

USS

UNITED STATES STEEL

News of Engineers

(*Continued from page 21*)

George Rufus Brown, of Houston, Tex., has been named Engineer of the Year by the San Jacinto Chapter of the Texas Society of Professional Engineers. Mr. Brown is executive vice-president of Brown & Root, Inc., Houston.

Dale S. McMillen, of St. Louis, Mo., has been appointed a district engineer with the Master Builders Company, of Cleveland, Ohio. His new duties will be primarily in the Rock Island District. Prior to joining the company in 1955, Mr. McMillen was on the staff of the U. S. Bureau of Reclamation.

Gordon Magnuson, of Whittier, Calif., has been appointed sales engineer of Gladding, McBean & Company's Pipe Products Division, in Los Angeles. Mr. Magnuson was formerly sales engineer for the Davidson Brick Company.

Channing B. Brown has been promoted to manager of the Industrial Power Department of the Duke Power Co. at Charlotte, N.C. Mr. Brown has been connected with Duke Power since 1922, and at the time of his promotion was industrial power engineer.

Irving E. Olsen was recently made a resident partner in the firm of Dames & Moore, soil mechanics engineers of Los Angeles, Calif. He was formerly engineer-in-charge of the Portland office. The firm's offices in both Portland and San Francisco have recently been moved. Their new addresses are 1220 S. W. Morrison St., Portland 5, Oregon, and 340 Market St., San Francisco 11.

George W. Howard has been promoted to the newly-created post of technical director at the Corps of Engineers' Research and Development Laboratories, Fort Belvoir, Va. Dr. Howard will serve as assistant to the director, in guiding the extensive program of basic and applied research, engineering design and development, and test of engineer equipment conducted at the installation. He has been with the Corps of Engineers more than twenty-three years, both as a civilian and as an officer, and was chief of the Laboratories' Technical Service Department prior to his promotion.

G. W. Howard

Ivan Sattem, of Upper Montclair, N.J., has been named manager of organization and methods planning at the Federal Telecommunication Laboratories, Nutley, a division of International Telephone and Telegraph Corp. He was technical services manager until his new appointment.

Eugene Joseph Peltier, Captain in the Navy Civil Engineer Corps, is now Commanding Officer of U. S. Naval Construction Battalion Center, Port Hueneme, Calif. Captain Peltier was former assistant chief for maintenance and materiel, Bureau of Yards and Docks at Washington, D.C.

Walter Hiram Frick announces the formation of a partnership, Frick & Sweeney, consulting architectural engineers, with offices at 950 Century Building, Pittsburgh, 22, Pa.

John R. Hartley was recently promoted to general manager of Builders-Providence, Inc., Division of Builders Iron Foundries Industries, at Providence, R. I. Mr. Hartley joined B-I-F Industries in 1929 and has been vice-president and manager of project sales since 1949.

J. R. Hartley

Edwin J. Dietrich, for the past six years consulting engineer with Lockwood, Andrews & Newman of Houston, Tex., has joined the engineering staff of Bernard Johnson & Associates, Houston.

(*Continued on page 96*)

Just off the presses!

THE FIRST COMPLETE TREATMENT OF

FOUNDATIONS

Design and Practice

By ELWYN E. SEELYE
Seelye Stevenson Value & Knecht, Consulting Engineers

Covers design, construction methods, costs, specifications, and field practice

Here, in one convenient volume is complete, up-to-the-minute information on all phases of foundation work, including subsurface exploration, inspection, foundation reports, specifications, contracts, and design. Thoroughly practical and authoritative, it is written by the man who has probably designed more building foundations than any other living engineer. Provides all necessary elementary information and proceeds through the important *do's* and *don'ts* of successful foundation design and practice. Includes the first treatment of cathodic protection for steel structures in salt water.

Broader in scope than any other work on the subject, it includes such topics as:

- **waterproofing**
- **underpinning**
- **industrial floors on ground**
- **foundations for pavements**
- **foundations for bridge abutments**
- **economics of design**
- **design tables for reinforced concrete footings, retaining walls, and steel pipe piles**
- **dam foundations**
- **pipe and sewer foundations**
- **applied soil mechanics**
- **standard specifications**
- **frost data and permafrost**
- **small house foundations**
- **building code practice**
- **earthquake design**
- **structural design data**

1956
466 pages
Hundreds of drawings and illustrations
$16.00
Mail this coupon today for your ON-APPROVAL copy

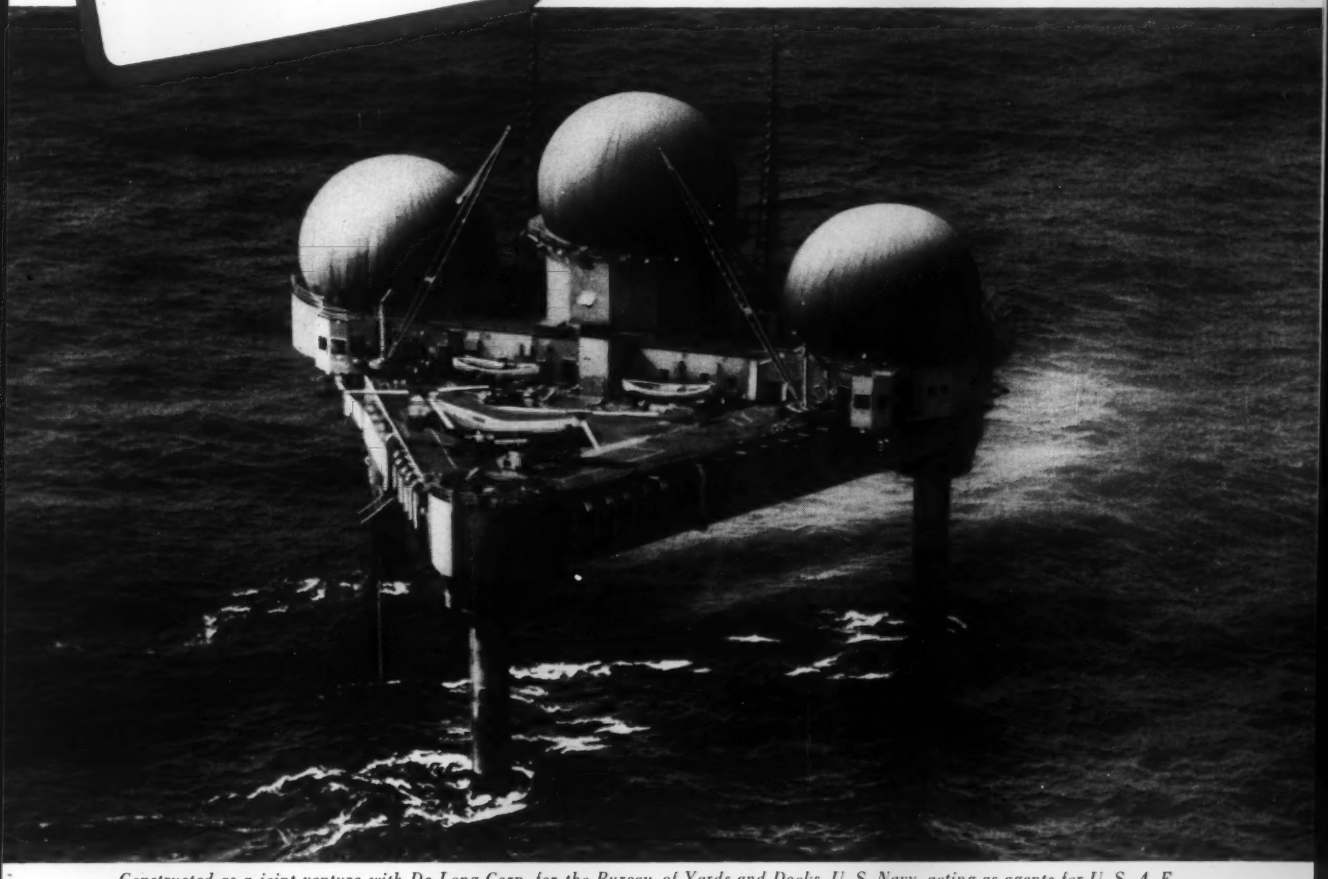
JOHN WILEY & SONS, Inc. **CE-66**
440 Fourth Ave., New York 16, N. Y.

Please send me FOUNDATIONS to read and examine ON APPROVAL. In 10 days I will return the book and owe nothing, or will remit $16.00 plus postage.

Name.....
Address.....
City..... Zone..... State.....

( ) SAVE POSTAGE. Check here if you ENCLOSE payment, in which case we pay postage. Same return privilege. Refund guaranteed.

completed ... another RAYMOND first!



Constructed as a joint venture with De Long Corp. for the Bureau of Yards and Docks, U. S. Navy, acting as agents for U. S. A. F.

The Georges Bank Advance Radar Warning Station

The above photograph shows one of the outstanding construction achievements of 1955.

This "Texas Tower", 110 miles off the coast of Cape Cod in 56' of ocean, is the first structure ever to be constructed under such conditions. It has already withstood the lashings of two hurricanes and a raging Nor'easter . . . a tribute to the half-century of Raymond experience in every type of foundation construction.

For a showing of the motion picture depicting the installation of this "Texas Tower" to engineering and construction groups, contact your nearest Raymond District Office.

RAYMOND'S DOMESTIC ACTIVITIES . . . Foundations . . . Marine Structures and Offshore Construction . . . Heavy Construction . . . Soil Investigations.

RAYMOND'S ACTIVITIES ABROAD . . . Complete service for all types of construction.

RAYMOND

CONCRETE PILE CO.

140 Cedar Street, New York 6, N. Y.

BRANCH OFFICES
in principal cities of the United States, Canada, Central and South America.

AROUND THE WORLD · FOUNDED 1897 ·

All-round Dirt-Moving Team

for low-cost operation

LARGE ENOUGH to get jobs done fast—
SMALL ENOUGH for profitable use on low-yardage jobs

HD-11 crawler—75 drawbar hp. Gets more work done faster and at lower cost with these on-the-job advantages: shock-absorbing, all-steel, box-A main frame; rugged final drives that ride on straddle-mounted roller bearings; 1,000-hour lubrication intervals for truck wheels, idlers and support rollers; ceramic-lined master clutch that requires fewer adjustments, provides extra long life; plus new operator convenience that includes a big foam rubber seat and 24-volt direct electric starting.

AC-106 scraper—6.1 yd struck, 7.5 yd heaped. Plenty of features for fast, low-cost dirt moving: curved, offset cutting edge and "center-boiling" loading action; wide, low bowl to keep center of gravity low; high-flotation tires and ample ground clearance; maximum stability for working on slopes or rough terrain; 81-in. apron opening and forward-forced ejection for quick, clean dumping; easy adjustments; simple sheave system.

• • •

See these and other important earth-moving advantages of Allis-Chalmers crawler tractor and scraper combinations at your Allis-Chalmers construction machinery dealer. He has complete facilities to serve you—factory-trained servicemen, factory-approved methods and complete stocks of True Original Parts.

ALLIS-CHALMERS, CONSTRUCTION MACHINERY DIVISION, MILWAUKEE 1, WISCONSIN

ALLIS-CHALMERS

do you know that

About 80 percent of all professional engineers are employees? This is one of the findings of a recent survey of professional standards and employment conditions made by Engineers Joint Council. The results of the survey are reported in this issue under the title, "Are Employment Conditions Consistent with Full Professional Stature?"

Public water system construction needs will exceed $19 billion in the next twenty years? The Water and Sewerage Industry and Utilities Division of the Department of Commerce bases this estimate upon an anticipated population of 206.6 million in 1975, which would require an increase in the average daily water delivery from 17 to 29.8 billion gallons. Copies of the Division's "Summary of Information on Public Water Supplies" may be purchased from the Department of Commerce (Washington 25, D.C.) for 10 cents apiece.

Over 30 million tons of gravel are to be dumped into Great Salt Lake? A giant conveyor system that will generate its own electricity and set new speed records for material handling is being built to move this tremendous tonnage of gravel into place from a Utah hill 400 ft above the famous lake. The gravel will be used for a 13-mile fill for the Southern Pacific Railroad across the lake, replacing a 52-year-old trestle supported on wood piles. Morrison-Knudsen, Inc., is the contractor, and Hewitt-Robins is building the $1,700,000 conveyor system. The big earth-moving operation will take 26 months.

Like everything else, highway costs are rising? In the first quarter of 1956, the price level for federal-aid highway construction was 1 percent higher than in the preceding quarter. With 1946 as the base year, the first-quarter index is 4.2 percent above the 1954 average, and 3.1 percent below the average for the peak year of 1952.

A new use has been found for radioactive isotopes? For the first time they will be used to trace the dispersion of sewage effluent in ocean waters. This announcement comes from Hyperion Engineers, an organization formed to design additions and improvements for Los Angeles' sewerage system and Hyperion Treatment Plant. The unusual application is part of oceanographic studies designed to guard against beach pollution when the modified plant, with its increased sewage flow, is placed in operation.

The next ten years augur ill for the traffic situation? If you think today's highways are a mess, says the National Safety Council, just wait another ten years! By 1966, we are told, there will be 20,000,000 more motor vehicles, a total of 82,000,000, jamming the streets and highways. They will travel 825 billion miles a year, and annual traffic fatalities will be around 53,000—unless more stringent traffic safety programs can be put into effect.

Irrigation is needed and practiced in all 48 states? There are 26.7 million acres under irrigation in the United States. California is the leader with 181,000 acres. Oregon is second with 98,000 acres, and Washington third with 67,000 acres. A forthcoming (July) article will discuss irrigation in the Lake Okeechobee area of Florida.

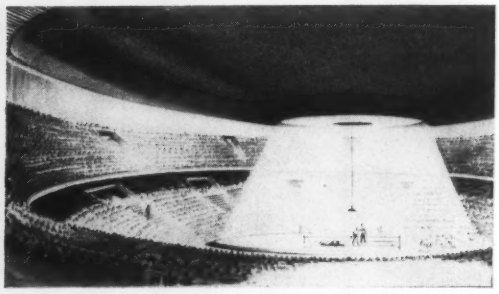
This is the centennial of the "Age of Steel"? The year 1856 marked the beginning of the "Age of Steel," according to the American Iron and Steel Institute. In that year British Henry Bessemer announced the discovery of a process of blowing air through molten iron to remove impurities, and his countryman Robert Mushet received a patent for a manganese compound which helped convert Bessemer's product into steel. The Bessemer process of making steel predominated in this country until 1908. Now about 90 percent of all our raw steel is made in open hearth furnaces.

The population of the world—2.6 billion—will increase two to four times in the next 100 years? This estimate appears in the California Institute of Technology "Resources of the World: A Speculative Projection." The report states that technology can supply adequate food, shelter, and clothing for the earth's people by applying brain power to our most common substances—sea water, air, sunlight, and ordinary rock. "Technological brain power" is the critical resource we will need for this.

The July issue will bring you Knoxville Convention papers? Typical of the many papers on the Convention agenda is a July article on "The Role of Civil Engineers in Multi-Purpose River Developments," by Brig. Gen. Herbert D. Vogel, M. ASCE, chairman of the board of the Tennessee Valley Authority.

Pittsburgh is pressing plans for the Annual Convention? This year the Pittsburgh Section will be host to the Annual Convention, traditionally held in New York. Of special interest in this interesting meeting will be a Power Division session on the Shippingport Power Station, the first atomic energy power plant to be integrated into a utility system. There will be inspection trips to this important construction project, too. Honorary Member Park H. Martin is general Convention chairman.

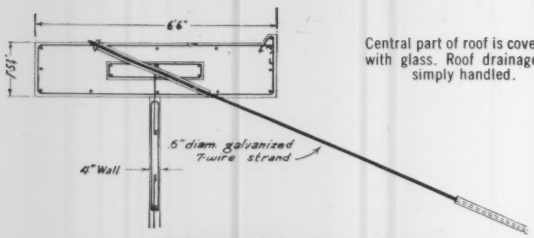
Breathtaking *isn't too strong a word...*



for this 83-ft.-high, 310-ft.-diameter concrete stadium, with 4-in.-thick wall and 850-ton suspended prestressed roof . . .

4"-thick wall was concreted with 'Incor', forms lifted daily. Roof is supported by cables extending from concrete ring atop wall to steel ring at roof's center.

Roof consists of 9000 concrete slabs 2" thick, hooked to cables; prestressed by overloading with brick, then concreting joints, later removing overload.



Central part of roof is covered with glass. Roof drainage is simply handled.

● Montevideo's cylindrical concrete stadium, to seat 20,000, is a masterpiece of simplicity and economy. Wall was built by lift-form method, using 'Incor'* 24-Hour Cement, produced by Lone Star's Uruguayan subsidiary, for speed, economy, quality.

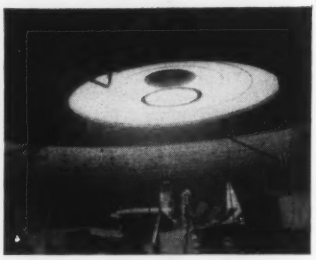
Roof, built without forms or falsework, is supported on 256 seven-strand cables, strung between a ring 6 ft. 6 in. wide and 1 ft. 5¾ in. thick, concreted around top of wall, and an 18-ft.-diameter steel ring at roof's center.

Working out from center, 9,000 precast concrete slabs, 2 in. thick, with reinforcing rods projecting laterally and shaped into hooks, were fastened to the cables. Roof was then prestressed by overloading 50%, placing concrete in slab joints, and removing overload after concrete had hardened.

Central part of roof (65 ft. diameter) was left open and covered with glass, as was a strip next to wall, to provide light and ventilation and to minimize wind suction.

Talk about simplicity! Clearly, the designers solved their problems by taking fullest advantage of concrete's great flexibility and "doing what comes naturally".

*Reg. U. S. Pat. Off.



STADIUM, MONTEVIDEO, URUGUAY

Designed and built by:
MONDINO Y VIERA, LTDA.

Consultants:
ALBERTO S. MILLER, C.E.
and
LUCAS RIOS
Architect

Consulting Engineers, Roof Design:
THE PRELOAD COMPANY, INC.
New York

LONE STAR CEMENTS COVER
THE ENTIRE CONSTRUCTION FIELD

LONE STAR CEMENT CORPORATION

Offices: ABILENE, TEX. • ALBANY, N. Y. • BETHLEHEM, PA.
BIRMINGHAM • BOSTON • CHICAGO • DALLAS • HOUSTON
INDIANAPOLIS • KANSAS CITY, MO. • NEW ORLEANS • NEW YORK
NORFOLK • RICHMOND • WASHINGTON, D. C.

LONE STAR CEMENT, WITH ITS SUBSIDIARIES, IS ONE OF THE WORLD'S LARGEST CEMENT PRODUCERS: 18 MODERN MILLS, 38,000,000 BARRELS ANNUAL CAPACITY

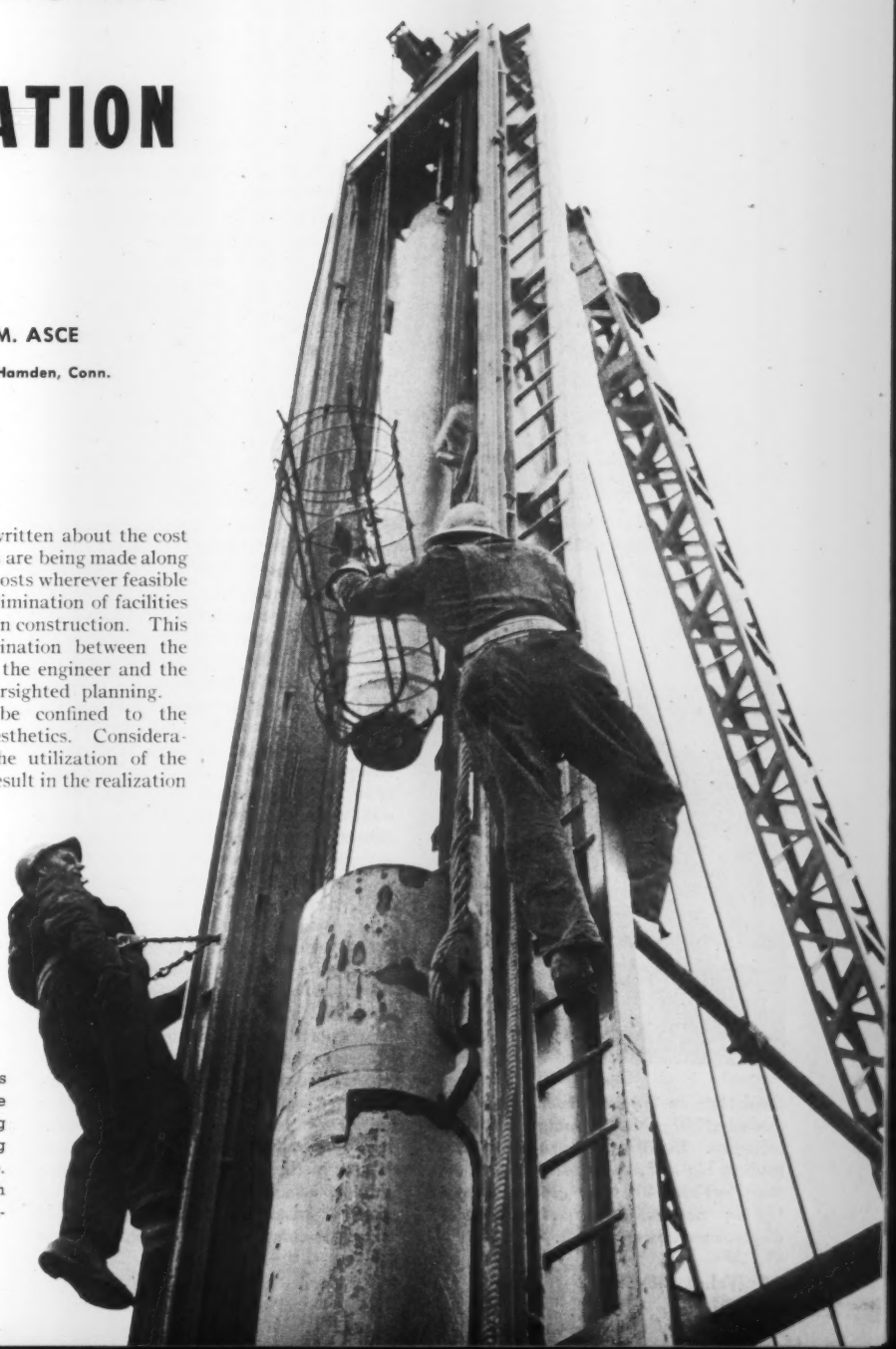
To save school construction dollars, look to the FOUNDATION

ARTHUR G. BEAULIEU, M. ASCE

Arthur G. Beaulieu Associates, Hamden, Conn.

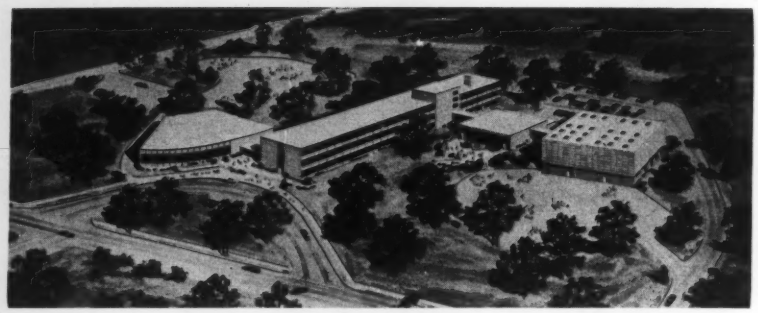
Much is being said and written about the cost of school buildings. Efforts are being made along many lines to reduce such costs wherever feasible and to do so without the elimination of facilities and the sacrifice of quality in construction. This requires the utmost coordination between the school board, the architect, the engineer and the constructor, and careful farsighted planning.

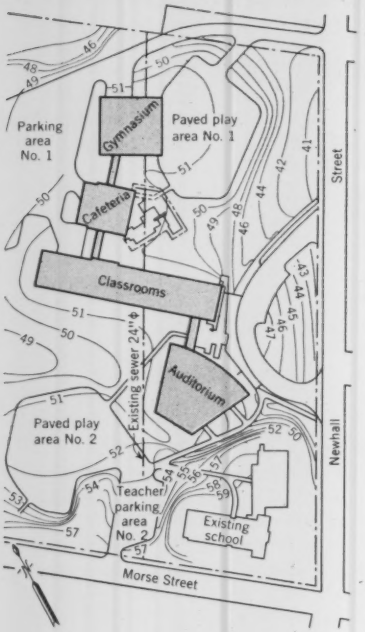
This planning cannot be confined to the arrangement of space and esthetics. Consideration must be given to the utilization of the site in a manner which will result in the realization



In driving Franki caisson, casing is driven first and then withdrawn while concrete is rammed down, forming bulb at pile base. Here reinforcing cage is about to be dropped into pile. Piles vary from 10 to 37 ft in length and contain from 15 to 55 cu ft of concrete in bulb alone.

FIG. 1. Four buildings of Hamden Junior High School were arranged to take maximum advantage of rolling bearing stratum. Pile lengths were thus reduced and a large saving realized in foundation costs. Buildings in sketch at right are (left to right) Auditorium, Academic Building, Cafeteria, and Gymnasium and Shop Building.





Load tests on Franki caissons were conducted at 150 percent of design load at two locations. Result of test is shown on face of loading bin as follows: design load, 140 tons; test load, 210 tons; gross settlement, $^{7}/_{32}$ in.; net settlement, $^{5}/_{16}$ in.; length of displacement caisson, 31 ft.

of maximum economy in foundation construction and land improvement. This is particularly true where soil conditions are poor and where soil-bearing footings are unsuitable.

The buildings should be grouped and designed to fit the site and not the site altered to fit a preconceived grouping of buildings. To permit this approach, it is necessary to take borings and to collect all available information relating to the substrata and the geological formations. Otherwise it will be impossible to avoid difficulties during construction and additions to the "contract sum." Architects and engineers have a prime responsibility in this respect. Construction must be completed without exceeding the amount of money allocated. The owner, through his representatives, building committees, etc., by being flexible in his requirements and demands and in his acceptance of professional guidance, can be of great assistance in the attainment of this mutual objective.

The Junior High School for the town of Hamden, Conn., compares favorably with many such projects constructed at various locations in this country. The type of construction does not differ widely from most jobs where sound, substantial, and economical construction is the major objective, second only to the educational facilities to be provided. The site and soil conditions however cannot be considered as average, and great care was required to keep the cost per square foot in line with prevailing costs for this type of facility. The cooperation and open-mindedness of the Board of Education and the latitude given by them to the architects and engineers in planning, locating, and arranging the four buildings of this project on an unusual site resulted in definite and very appreciable savings to the taxpayers of the town. Without this freedom of action it would not have been possible for the architects and the engineers to complete this project on this particular site at the cost price of $13.85 per sq ft of floor area, including all piling and foundations, but excluding site improvement and landscape work. (This price also includes $115,000 for built-in equipment such as lockers, laboratory equipment, auditorium seating, folding partitions, dumb-waiter, basketball equipment, etc.).

The school plant to be provided consisted of four buildings, connected by covered passageways (Fig. 1), as follows:

1. An Academic Building, 69 × 322 ft to include 45 classrooms, laboratories, library, offices, rooms for the administrative and teaching staffs, and the central heating plant. This unit was eventually designed and built as a three-story structure.

2. An Auditorium to seat 550 persons and to include music study and practice rooms. This building is a one-story unit. Its dimensions were such that it could be located at the southeast corner of the property on sandy soil of good bearing quality. It required piles at only one corner, the northwest. The total area of this unit is approximately 12,000 sq ft.

3. A Cafeteria Building located between the Gymnasium and the Academic Building, approximately 82 ft wide by 92 ft long. This is a one-story building with mezzanine, having direct access to the second floor of the Gymnasium and to the stair hall of the Academic Building through multi-story glass-enclosed passageways. The building has complete kitchen facilities at the rear and a dining area at the front on the ground floor.

4. The Gynamisum and Shop Building is a two-story structure 103 ft 6 in. × 113 ft. The gym, which is in the front of the building on the second floor, has a ceiling height of 20 ft to the bottom chord of the roof trusses. It measures 67 × 102 ft and can be made into two gyms

Franki displacement caissons were used throughout. They were extended above ground to first-floor level using Sonotube forms. All buildings except Auditorium have crawl space below first floor for conduits and piping.

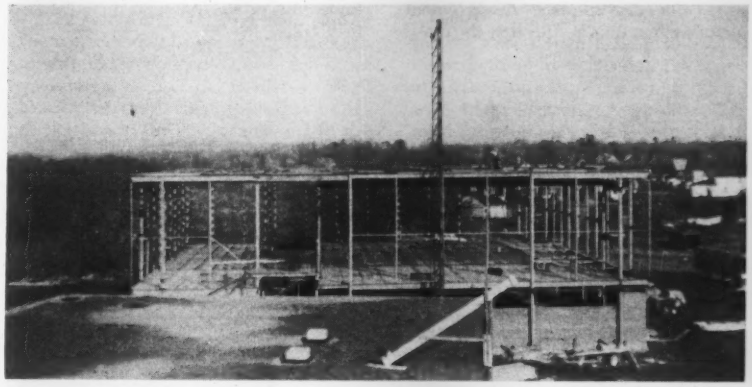
51 × 67 ft, one for boys and one for girls. The rear part of the second floor contains volley-ball and hand-ball courts and miscellaneous supply and storage rooms. The first or ground floor accommodates shower, wash, and locker rooms and miscellaneous shops. All rooms are accessible from a main passage or corridor which connects with the Cafeteria at ground floor and stair platform. The total floor area of all units in this building project is approximately 120,000 sq ft.

The site consists of approximately 21 acres, which include only about 2 acres of high and firm ground. The remaining area is low lying and marshy land, of which about 12 acres were filled in recent years with manufacturing plant refuse and covered with earth, gravel and other materials excavated from road building and other construction projects. Elevations of the area built upon ranged from a high of approximately 50 ft above mean low water to a low of 40 ft. Ground water was found to occur approximately at El. 30.0.

A 24-in. sanitary sewer, serving the northerly section of the town, runs through the site from north to south at about El. 48 and 300 ft west of and parallel to Newhall Street. This line was not to be disturbed or its operation interrupted at any time during construction. Therefore the buildings were located so that this pipeline would run through the Gymnasium crawl space, east of the Cafeteria, through the Academic Building crawl space, and west of the Auditorium. Footings were generally located to avoid this pipeline. In one case, at the Academic Building, it was necessary to provide a special footing at the exterior wall because of the close proximity of the pipeline to the centerline of the caisson.

Beneath the refuse and other fill, the soil was found to be sand of varying density. Under percussion tests, the upper stratum of this sand offered a certain resistance which decreased as the depth increased, the initial resistance not being equaled again in many instances until a penetration of 50 to 60 ft had been reached. Since the fill was entirely inadequate to support the building loads, the use of some type of concrete pile was indicated. It was obvious that to realize maximum economies in foundation costs, the several building units of this project would have to be arranged and designed to:

1. Utilize the site to the best advantage, giving full consideration to the proximity of the firm subsurface material and the subsurface topography.
2. Utilize the areas requiring minimum penetration of piles to obtain the resistance and carrying capacity necessary to safely support the building units.
3. Plan the buildings and their load distribution so that piles or other means of load transfer to the subsoil could be utilized with maximum effectiveness.



Gymnasium and Shop Building has standard steel framing with long-span open-web joists for roof over gymnasium. Note that exterior columns are outside masonry wall at the first floor.

Using 35 tons as the unit capacity for several types of piles, studies were made to determine the most feasible building panel dimensions for one-, two-, and three-story buildings. As the Academic Building was to be the largest structure, it was used to determine costs and weights. In this study six types of floor construction were analyzed. Every consideration was given to building weight in order to minimize foundation costs. With the floor panel size selected, the studies proved that maximum utilization of piles would be realized only by adopting multi-story buildings.

Several types of floor systems were analyzed for weight and cost. It was determined that, with bays approximately 20 × 27 ft, open truss joists with Corruform spot-welded to them, and a 2-in. concrete slab plus a 1-in. finish, resulted in the lightest loads and the lowest cost. In addition this panel size and type of construction not only required

the minimum number of piles but enabled these piles to be used to maximum efficiency.

Based on piles of 35-ton capacity, the percentage utilization of this capacity for the several buildings was approximately as follows:

Academic Building, 3 stories	96%
Gymnasium and Shop Building, 2 stories (high second floor)	96%
Cafeteria, 1 story and mezzanine	56 to 72%
Auditorium, 1 story	*

* Only the northwest corner of this building is supported on piles. The major area is supported on soil-bearing footings of spread and continuous types.

Although the basic design of the foundations called for concrete cast-in-place piles, an alternate design was included for cast-in-place displacement caissons extending up through the crawl space to the under side of the main floor-carrying girders, thus eliminating all concrete pile caps and piers. Bids were obtained for both types.

The basic design, with cast-in-place concrete piles, called for 434 piles, and required pile caps to accommodate groupings of from 2 to 9 piles, and piers at interior columns averaging 5 ft in height. The total cost of these piles, as quoted by the low bidder, to whom the contract was eventually awarded, was $67,570. This cost was based on a pile length of 30 ft. Any length in excess of the basic length was to be at a unit cost of $2.75 per ft.

The alternate bid for displacement caissons, or forged concrete footings (of the subcontractor, Franki Foundation Co. of New York), was a guaranteed lump sum of $53,300, and included two load tests.

The displacement caissons were to be driven to support 35 tons, 105 tons and 140 tons each. The use of this type of pile made possible the omission of all concrete caps and piers for a total net saving of $23,000. The cost of these caissons was less than 50 cents per sq ft of floor area. This alternate bid was accepted.

The shaft of the displacement caisson is 22 in. in diameter and the maximum load on the concrete is about 750 psi. The caissons vary from 10 to 37 ft in length and contain 15 to 55 cu ft of concrete in the bulb alone. The specifications contained the following provisions:

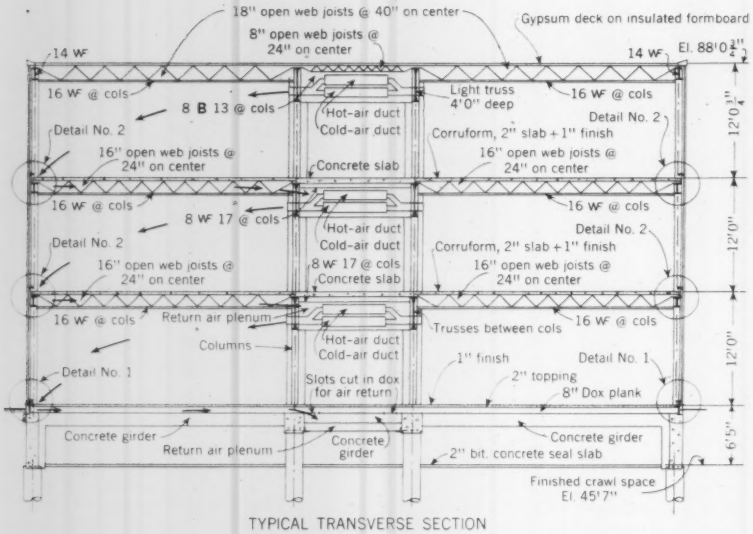
Foundations below beams shall be displacement caissons. Such caissons shall be installed by displacing the soil by driving a tubular casing at least 20½ in. in diameter with a closed end into the soil with a driving rig capable of developing at least 120,000 ft-lb of energy per blow.

The tubular casing shall be driven to a penetration of not over ¾ in. per blow of 120,000 ft-lb of energy.

At this depth a footing shall be formed by ramming concrete into the soil with blows of 120,000 ft-lb.

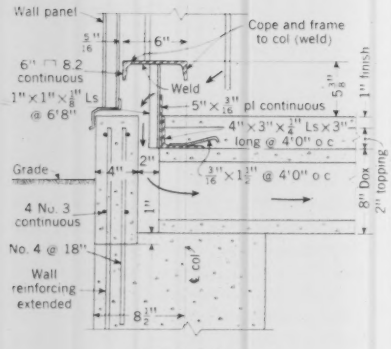
For 100-ton bearing capacity, 30 such blows shall be required to ram into the footing the last 5 cu ft of the concrete. For all other loads the number of blows shall be proportionate.

Upon completion of the footing, the casing shall be gradually withdrawn while the shaft is being formed by the placing of successive charges of concrete therein not in excess of 5 cu ft each. Each charge is to be rammed and compacted by not less than 3 blows of 30,000 ft-lb each.

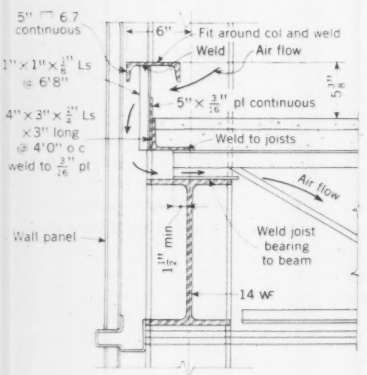


TYPICAL TRANSVERSE SECTION

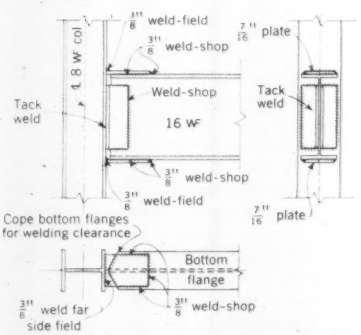
FIG. 2. Transverse section of Academic Building shows how warm or cool air circulates through classrooms and is exhausted through base of wall into plenum between ceiling and floor, as shown in Details Nos. 1 and 2. Note also 4-ft light fabricated trusses along corridor wall between interior columns. These trusses provide longitudinal stiffness to structure. Transverse stiffness is secured by moment connections between transverse beams and columns. See diagrams directly below.



DETAIL NO. 1



DETAIL NO. 2



TYPICAL BEAM-TO-COLUMN CONNECTION AT TRANSVERSE BENTS

Concrete is to be 1:2:4 mix, of well-graded, sound aggregate the largest of which shall not exceed 1 in., and is to have a water content of not in excess of 4½ gal per bag of cement.

Where dowels are called for in the drawings, they shall be placed as directed by the engineer.

Load-test results

Two load tests were performed on Franki caissons. The test caissons were loaded to 150 percent of the total live load plus dead load, or 160 and 210 tons respectively. The test loads were applied by a hydraulic jack set on the caisson and reacting against earth-filled cribs constructed directly above the caisson to be tested. Maximum settlement occurred on the 210-ton caisson. This settlement was $^{5}/_{64}$ in. after elastic recovery and after the caisson had sustained the full load for 37 hours without movement. Of interest is the fact that although both caissons tested varied so greatly in length of shaft, both attained comparable resistance in similar types of soil, according to borings and percussion data.

Because of the inadequacy of the fill to support load, the first-floor slab in all buildings except the Auditorium is of the supported type. Thus a crawl space is provided under the entire floor area of the Academic, Cafeteria, and Gymnasium Buildings, supplying ample room for building service piping and conduits for water, sewage, gas and electricity. The floors of the crawl space in all buildings are of bituminous concrete to form primarily a ground seal and a protection against rodents, and to provide a flexible surface in the event of ground settlement.

Building frames

Several factors influenced the structural design of the buildings, particularly the three-story Academic Building. These factors were as follows: (1) The all-panel type of exterior wall construction, (2) the absence of adequate walls to brace the buildings transversely, and (3) the many clearances required for heating ducts and the heating system in general.

With regard to the first of these factors, the entire north and south sides of the Academic Building are glass and insulated porcelain panel. The same construction is used for the front of the Cafeteria and of the Auditorium. In the Academic Building, the walls of the corridor, which bisects the building longitudinally, extend the full length of the structure (Fig. 2). Normally such walls are sufficient for bracing in the longitudinal direction. However in this particular instance they could not be relied upon since they could not be extended to the under side of the floor above, and were to be of 4-in. cinder blocks with many openings for doors, ducts, panels, etc.

The transverse walls on each side of the corridor do not occur opposite each other on each floor, or above each other on different floors. For these reasons all bracing of the structure had to be incorporated in the steel frame and in the floor systems.

The design loads were as follows:

For classrooms	60 psf
For corridors, halls and stairs, and for mezzanine in Cafeteria	100 psf
For shop floors	150 psf
For Gymnasium Building	100 psf

Heating is provided by a hot-cold double-duct mixed-air system. The warm air is delivered to the rooms from ducts above the corridor ceilings. Air is exhausted from the rooms through continuous slots along the floors at the exterior walls, thence through the space between the floor and the ceiling below, to a plenum above the corridor ceiling of the floor below (Fig. 2.) This air circulating system precluded the use of solid girders at corridor walls to support the floor and construction above, since grilles and ducts had to be located in corridor partitions near the ceilings. Therefore light fabricated trusses framed between columns at corridor walls were used to provide clearances for ducts, grilles, and certain piping. These trusses were also designed to act as longitudinal stiffening trusses. They are 4 ft deep and the corridor ceiling framing is attached to the bottom chord. Transversely the building is stiffened by the use of top and bottom welded moment connections at exterior and interior columns and beams.

The first floors of all buildings except the Auditorium were constructed of precast concrete units—the Dox system. These units span the full width of the classrooms from corridor wells to exterior walls and serve as return air ducts from the rooms to the plenum under the first-floor corridor. Concrete topping up to 2 in. thick was applied to the Dox planks depending on the span. Although all planks were designed as simple spans, negative steel was placed in the topping at all supports to prevent any cracking with might occur as a result of the varying degree of fixity and negative moments at these supports.

The long-span trusses and under side of roofs are exposed in the Cafeteria Building and on the second floor of the Gymnasium and Shop Building. The roofs are poured gypsum on acoustical and insulating tile supported on T-sections.

In the passageways between buildings, all floors and roofs are of flat-slab concrete with 8-in. channel facias. Walls are of glass and metal panels. Lally columns are spaced back of mullions approximately 15 ft on centers and have shear heads of 6-in. I-beams welded to them and projecting 3 to 6 in. toward the center of the passageway.

Lightweight concrete was used for floor and roof slabs of these passageways. Its weight is 108 lb per cu ft, and tests showed a strength of 3,000 psi in 28 days. Lelite aggregate was used.

The architect for this project was Warren Ashley, AIA, of West Hartford, Conn., with George Burbank, project captain and architect's representative. The mechanical engineer was Hubbard-Lawless and Blakeley of New Haven, Conn. The structural engineer was Arthur G. Beaulieu Associates of Hamden, Conn., and all foundations and structural designs were developed under the direction of the writer. Engelhardt, Engelhardt and Leggett was the School Consultant. The Hamden Town Board of Education was represented on the project by William Urbach, who is Clerk of the Works. Charles Currier and Associates of West Hartford was the landscape architect. The general contractor was the Fusco & Amatruda Company of New Haven, Conn., which subcontracted the caisson work to the Franki Foundation Co. of New York.

Buildings of Hamden Junior High School are ready to receive aluminum frames and sash and insulated porcelain panels. From left to right they are: north side of Auditorium (one story), north side of Academic Building (three stories), east side of Cafeteria (one story), and east side of Gymnasium (two stories).

Welded-stud shear connectors for

K. R. SCURR, M. ASCE

Bridge Engineer, South Dakota Department of Highways, Pierre, S. Dak.

When the old bridge over the Bad River at Fort Pierre, S. Dak., betrayed signs of dangerous infirmity and lack of capacity for modern loads and traffic volumes, serious consideration had to be given to its replacement by the South Dakota Highway Department. As there was considerable local interest in the old structure, a search of historical records was made to establish its origin. It was easily discovered that the Verendrye brothers visited the site in 1743, leaving a lead plate marker, and that Lewis and Clark made this point a port of call in 1805. Neither of these gentlemen made mention of this 270-ft span in their record of events, in spite of the contentions of a critical citizenry that the bridge was a relic of those times. However, its inadequacy was incontestable.

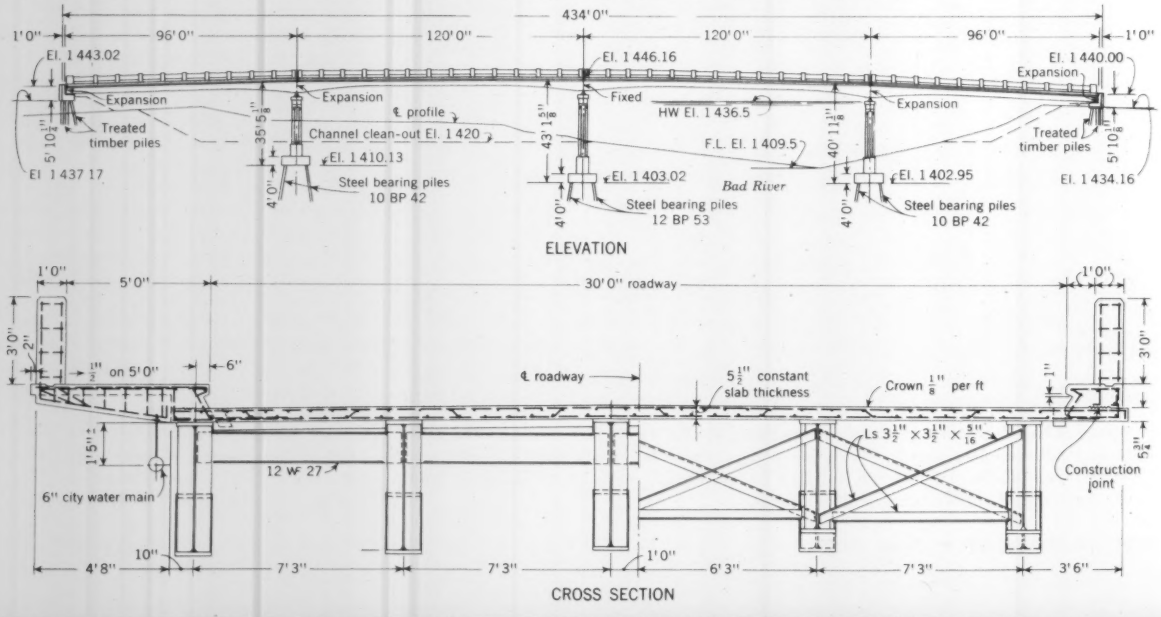
A number of factors had to be taken into consideration in preparing the design for the new structure. The usual demands by adjacent property owners that their interests be maintained inviolate led to the adoption of a geometric design, and the use of a combination of materials and construction techniques that might not be desirable or economical at another site. The heavy ice and uprooted trees carried by the stream at flood stages required the use of comparatively long spans, while the heavy summer traffic, consisting of outsize combines, farm machinery, and earth-moving equipment for the Missouri River Basin development projects, made trusses with overhead bracing undesirable.

To provide a quick descent to established street grades it was necessary to place the entire structure on a vertical curve, and the limited headroom demanded that the long girders used be as shallow as possible to keep the bearings out of high water and at the same time permit an easy transition to established street grades. The location in mid-city justified a pleasing architectural treatment, in fact, made this one of the essentials of the project.

The structure finally selected as the best solution for these multiple and sometimes contradictory requirements was a four-girder, all-welded, continuous deck bridge with four spans of 96 ft, 120 ft, 120 ft, and 96 ft (Fig. 1). For eye appeal as well as economy, girders of variable section were chosen and the whole continuous unit was placed on a vertical curve of 5,000-ft radius.

To achieve the shallow section that was desirable, the girders were specified to be of A-242 low-alloy steel and were made composite with a lightweight floor using light-aggregate concrete with a strength of 4,000 lb per sq in. (psi) and weighing approximately 90 lb per cu ft.

FIG. 1. Bridge over Bad River at Fort Pierre, S. Dak., is of continuous-span, four-girder, all-welded type. It was designed to provide unlimited overhead clearance for outsize farm and construction equipment and maximum underclearance for flood waters. Composite cross section shows arrangement of floor beams and, at right, arrangement of cross bracing.



South Dakota Bridge

Bad River Bridge was completed in April 1956 at just over $10 per sq ft of usable surface. Old 270-ft truss bridge has been removed.

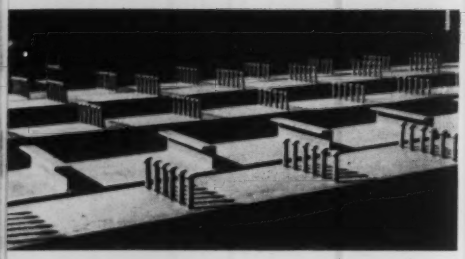
Although increased deflections go hand in hand with higher allowable steel stresses, these deflections were held within permissible limits by combining the continuous composite floor design with the reduced dead load of the light-aggregate concrete floor.

In previous composite designs by the South Dakota Department of Highways, the shear connectors consisted of angles or channels welded across the top flanges of the girders. This method gave satisfactory results for many years. However, it was noted that there was some warping of flanges, induced by the cross-flange welding, and that heat treatment was desirable for the relief of such stresses and straightening of flange sections. A continual search had been in progress for an adequate shear connector that would eliminate these undesirable side effects.

The use of small electrically welded

Girders are in place on piers ready for addition of floor reinforcing mat and forms. Note old bridge at left.

Stud connectors were welded to girders in regions of positive moment to obtain composite action between girders and lightweight concrete floor. In photo at left corrugated steel sheets are laid over wooden falsework between stud connectors to serve as form for reinforced concrete (made with light aggregate). Sheets were left permanently in place. In photo at right, floor reinforcing mat is partially in place in foreground. Note stud connectors on girders in background.



Comparative time and cost study was based on two types of shear connectors, as seen on girders in yard of fabricator, Egger-Scudder, Inc., at Sioux Falls, S. Dak. Old-type angle shear connectors are seen on second girder from front; other girders have new-type ¾-in. round studs 4 in. long, six being evenly spaced in the 13-in. girder width.

Operator in shop welds studs at rate of 5 or 6 per minute with aid of wooden loading box which holds six in position at one time. Comparative studies showed shop time for this operation was reduced to one quarter of that required for welding shear angles.

studs in the building industry pointed the way to what was considered a superior solution to the problem. An investigation carried out by Prof. C. P. Siess, M. ASCE, at the University of Illinois, confirmed the view that ¾-in. round studs electrically welded to the flanges would provide an efficient and economical method of attaining composite action between the steel girders and the concrete floor slab.

Although the contract had been let to Bonesteel & Hyde, Inc., on the basis of using angle shear connectors, and the quotation from the fabricator, Egger-Scudder, Inc., of Sioux Falls, S. Dak., had also been made on that basis, both the contractor and the fabricator were amenable to the substitution of ¾-in. round studs, 4 in. long, with heads, using six studs for each angle connector of 13-in. length, 3 in. × 2½ in. × ½ in. The contractor saw advantages in using the studs in connection with the fabrication of the floor reinforcing mat. The fabricator saw the possibility of reducing time in the shop and eliminating extra costs when some warping occurred. From the standpoint of the State Highway Department, the primary benefit would be the availability of a better connector with assurance of a positive bond to the concrete and elimination of the undesirable cross-flange welding. Secondarily, the state was interested in future economies that would result if the contractor and the fabricator realized the savings that were anticipated.

Arrangements were made to use the equipment of the Nelson Stud Welding Co. at the Egger-Scudder shop. Time studies were made and these disclosed that the labor and material costs of the stud welds were appreciably lower than those for the standard angle connectors in place. The biggest benefit to the fabricator, however, was the reduced time in the shop. This is most important because a larger volume of work can be handled, and shop space is always critical when there is a backlog of orders. The time in the shop per girder was only about one quarter of that required for the welding of angle connectors. The heat generated by the molten pool of metal, confined at the base of the stud by the ceramic collar, was quickly dissipated through the flange. Except at the connection itself, the metal did not attain temperatures that were more than warm to the hand.

The equipment, being automatic in operation, did not require the services of a highly skilled welder, although union conditions might demand such services. A total of 8,300 studs, ¾-in. in diameter and 4 in. long, with upset heads, were end-welded with a Nelson heavy-duty NS-9 stud welding gun, using a 2,000-ampere Nelwelder as the power source. With the aid of a simple wooden loading frame, which reduces handling by holding 6 studs in position at one time, the operator welded studs at the rate of five to six a minute.

The girders, with connectors attached in sections of positive moment, were trucked about 200 miles to the job site. Here it was found that the multiple studs substituted for each angle-type connector were an aid to the contractor in fabricating the reinforcing mat for the floor. Spacer bars were easily tack-welded to the studs and the positioning of the reinforcement was expedited and positively controlled.

Corrugated sheets served as forms for the under side of the floor. These sheets were laid on and fastened to wooden joists supported on wooden falsework. The sheets were left in place permanently. For pouring the concrete floor during the past winter, a heated canvas enclosure was provided. When the floor slab was poured, ordinary vibration insured complete bond to the studs without the special treatment that had been required on other bridges to insure absence of voids under the top flange of angle or channel connectors.

The design of the structure was based on AASHO H-20 loadings and AASHO allowable stresses for all materials. The 4,000-psi strength for the light-aggregate concrete in the floor was easily attained by using approximately 6½ bags of cement per cu yd and 5⅓ gal of water per bag of cement. The light aggregates used averaged approximately 118 lb of coarse aggregate and 118 lb of fine aggregate per bag of cement, with ½ lb of Pozzolith and 0.2 oz of air entraining agent per bag added.

This produced a concrete of excellent workability, having a 2½-in. slump, entraining and trapping 6 percent of air, and weighing approximately 90 lb per cu ft fresh weight. The average 28-day strength of cylinders was about 4,500 psi. A characteristic of light concrete is that finishing operations tend to bring the aggregate to the surface, whereas with conventional concrete the mortar is brought to the surface. Careful filling and striking off to grade, and minimum finishing with floats, counteracted this tendency.

The undercut design of the curve shown in Fig. 1 has non-mountable characteristics superior to the higher bevel-faced curbs that have been standard. This design provides an efficient long slot for drainage and aids in snow removal.

Bidding was close, and Bonesteel & Hyde, Inc., of Pierre, S. Dak., was the low bidder among eight competitors. In spite of the use of special materials, architectural treatment, and the uneconomical length of the spans required, the cost of the structure was only $10.10 per sq ft of usable surface.

ENGINEERING EDUCATION—

four-year course favored

E. R. HARRINGTON, A.M. ASCE, Director of Secondary Education, Albuquerque Public Schools, Albuquerque, N. Mex.

How does an engineer become "well educated?" More than thirty years ago when I received my diploma from an engineering college I thought I was educated. Then came a rude awakening. There were so many things I had not learned and so many more that had not even been in the curriculum. In the years that followed I often felt inadequate, and the addition of more than 400 semester hours of graduate work still left me lacking many things I needed. Throughout those years I read a lot about the inadequacy of the beginning engineer, the lack of preparation in the secondary schools, and the imperfections of the universities and colleges.

Inadequacy, long-standing complaint

Thirty years ago many people were demanding a five-year curriculum in engineering. This is not a new movement. At that time too, employers found their beginning engineers unable to take over jobs without a considerable amount of preliminary training. There is nothing new about that. Engineers of thirty years ago felt inadequately prepared in mathematics, the basic sciences, languages, English, and the humanities. I remember hearing speeches on this theme by John Hays Hammond, Herbert Hoover, Hon. M. ASCE, Charles M. Schwab, Thomas A. Edison, and C. P. Steinmetz. That was back in 1921. The situation has not changed. The engineer still does not graduate with all the preparation he needs to conquer the world.

It is readily admitted that engineering graduates are ill prepared in a four-year college course built on a three-year high school course. (I am speaking now of the present three-year senior high school course which follows the three-year junior high school course in most sections of the country.) Perhaps the student would be better prepared for college if he had a five-year instead of a three-year high school course. Certainly he would be more ready for advanced algebra, trigonometry, and physics at nineteen than at sixteen or seventeen. On the other hand of course, the student might obtain a greater fundamental understanding of mathematics, the basic sciences, and engineering in five years of work in an engineering school than he could in four years. As to whether he would then be fully ready to discharge his professional duties, I am not so sure.

Could it be that we are taking ourselves too seriously? Have we set our eyes on some goal that is not practicable? In the *Chemical and Engineering News* for August 22, 1955, there is a review of the earning power of graduates with different degrees. It was found that men with a five-year B.S. degree earned at the start only about 5 percent more than the four-year men. Does this show a trend toward giving added consideration to a five-year curriculum? I doubt it. It is noted that the five-year graduates holding an M.S. degree start at salaries about 25 percent higher than those holding even the five-year B.S. degree. This seems to indicate that employers do not set too great a store by the five-year B.S. degree. It could very well be that they are taking the realistic viewpoint that in any case they will have to teach the beginning engineer a lot of procedure on the job. And they want to get him started while he is still young and teachable.

Insistence on a five-year course might result in a smaller enrollment of engineers. One of the attractive features of an engineering education is that it offers a hard-working young man an opportunity to start making a living after four years of college. Up the ante and you may do a good thing for the apprentice schools for technicians but a bad thing for the supply of engineers. If a young man likes mathematics and science he may be drawn toward a career in engineering. But if he is faced with a five-year college course and an internship after that, he may hesitate. Perhaps he will decide to make it seven years instead of five and become a physician or a lawyer. He may take a second look at business administration. Perhaps he can barely afford four years—then he is likely to become a plumber or an electrician, consoled by the high starting wages.

It appears that engineering educators can ill afford to lengthen the curriculum sufficiently to make their graduates completely adequate. If they face the facts, they may well find, as I have, that they are not completely adequate either, and are not likely to be. Engineering is a game of continual learning. If an institution were to hold its students until they were really ready, it would have to graduate them into a home for the aged. In the meantime, employers would have become tired of waiting and would have started their own training program for engineers.

What is employer's responsibility?

Some suggestions might be made to the employer. There is the likelihood that in an increasingly complex society the employer will have to devote more and more time to supplementing the education of his employees. This will pay him in the long run and it is likely to be the only way he can keep going. The employer will have to recognize that graduation from college does not guarantee perfection; he may have to look in the mirror to realize this. And he may have to make better use of the engineers he hires—leaving the technician's work to the technician.

Finally, let's not jump on the secondary schools because of the inadequate preparation of their graduates. Modern education in the secondary schools is doing the best it can, just as the colleges are doing the best they can. More than two thousand years ago Aristotle listed some basic criticisms of the then "modern" education. The New England School Committee of 1856 criticized their "modern" education and longed for the good old days. The Board of Overseers of Harvard complained about the atrocious preparation of freshmen back in 1894. And yet, in 1902, the *New York Sun* editorialized on the good old days of education.

This has always been going on. The "old days" have always been the good days, and "modern times" have always been full of inadequacies—especially in the schools. Why not be realistic? Why not just meet our problems the best we can, taking what we get and doing the best we can with it? Rabelais said that an expert carpenter could do fine work even with poor material. Well, how good are we?

Taming the

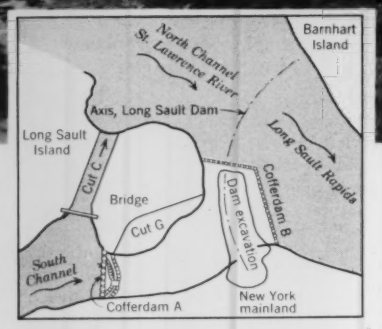


FIG. 1. Cellular Cofferdams A and B and Cut C were built for first-stage construction of Long Sault Dam. Cells in Cofferdam A are 60 ft in diameter, those in Cofferdam B, 48 ft. Area enclosed by Cofferdams A and B is seen in aerial view after unwatering. Bridge over Cut C is at far left. North Channel and Long Sault Rapids in St. Lawrence River appear beyond.

Mother Nature used all the forces at her command to fight man's efforts to control the Long Sault Rapids in the St. Lawrence River. A combination of the highest river flows in an 80-year period, one of the wettest fall seasons on record, subzero temperatures, heavy ice and snow storms, winter fog, continual high winds, and a wide variation in soil conditions, challenged the resourcefulness of those entrusted with this work.

The first major contract on the St. Lawrence power project, awarded to Dravo Corporation of Pittsburgh, called for construction and unwatering of the first-stage cofferdam for the Long Sault Dam. The power project is under construction by the Power Authority of the State of New York, of which Robert Moses is chairman, in cooperation with the Ontario Hydro-Electric Commission. The cofferdam, at the downstream end of Long Sault Island, completely blocks the South Channel, a section of river 420 ft wide which separates the island from the U.S. mainland (Fig. 1). This channel carries approximately 25,000 cu ft of water per second. The downstream leg of the cofferdam (Cofferdam B) extends out from the tip of the island into the famous Long Sault Rapids and then turns to connect with the U.S. mainland.

The job included four basic steps:

1. Excavating Cut C, a channel 120 ft wide across the lower end of Long Sault Island to carry the entire flow of the South Channel.
2. Placing eight cells of 60-ft diameter to form Cofferdam A across the South Channel.
3. Constructing 26 cells for Cofferdam B on its downstream side.
4. Unwatering the enclosed area and removing the overburden for construction of the first stage of the Long Sault Dam.

Each of these steps had its own problems and difficulties.

Early access to Long Sault Island was provided by a truck ferry which crossed a relatively quiet stretch of the South Channel a short distance above Cofferdam A. This ferry, consisting of 60 pontoon cubes decked with 3-in. oak planks, carried two 22-ton Euclid trucks on each crossing. A large $1^1/_2$-in. marine cable was used to guide the ferry across the channel, which has a current of 7 ft per sec (fps).

Difficult excavation in Cut C

Extreme variation in types of material was encountered in the excavation of Cut C. The top 7 to 10 ft of material was soft, sandy silt and clay that could be dug easily. Below this, a layer of soft, saturated blue clay 20 ft thick proved difficult to handle. This

Long Sault Rapids

JOHN H. PATTERSON, J.M. ASCE

Engineer, Contracting Division, Dravo Corporation, Pittsburgh, Pa.

material usually had the consistency of modeling clay and would continually stick in the dragline buckets and Euclid trucks. When placed in water it became soupy. In the heated truck beds it baked like pottery. This clay caused additional headaches when it was placed in the disposal area.

Bottom material in the cut consisted of a very compact glacial till which in places could not be dug by a $1^3/_4$-cu yd shovel. It finally had to be drilled and shot. Excavation was further hampered by an abnormally wet autumn which kept the haul roads almost bottomless most of the time.

Rock dike poses special problems

The swift current, plus the head differential required to force the flow of the South Channel through Cut C, made it impossible to construct Cofferdam A without first building a temporary rock dike across the channel immediately downstream of the cofferdam location. This rock dike posed special problems because scarcity of large-size rock in the vicinity prevented use of the common end-dump method to complete the dike closure.

A modified end-dump method was worked out to keep the size of rock required below five tons. A special closure sled 47 ft wide and 115 ft long was fabricated with a timber crib on each end. Each crib was 19 ft wide, 45 ft long, and 24 ft high. Three jointed steel beams were used as runners for this unique sled. The assembly was built on the shore of the mainland and pulled out into the deepest part of the channel (approximately 120 ft from shore) before the rock dumping operation began. The sled was pulled into the river with cables attached to three cranes and a bulldozer on the island.

With the closure crib in place, the rock dike was started by end-dumping quarry-run material from the mainland out to the nearest timber crib. A crane filled both timber cribs with selected rock to stabilize the closure unit. Large riprap stones were placed around the sled to reduce scour.

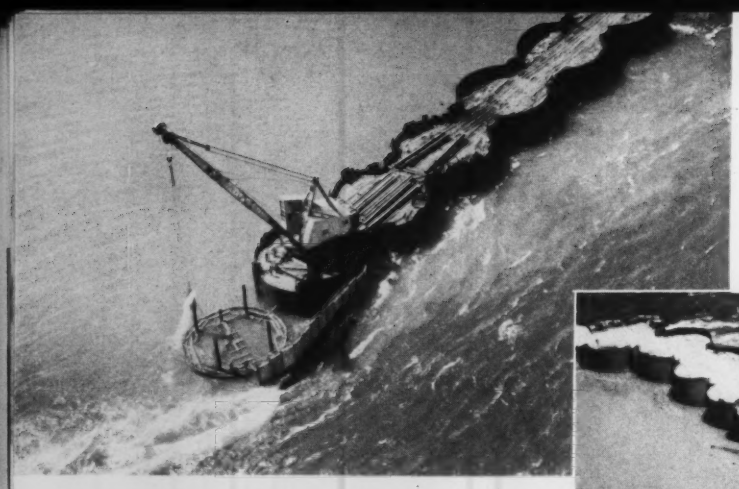
Work was then started to extend the rock dike out from the shore of Long Sault Island by end-dumping suitable material previously stockpiled on the island. As the gap between this end of the dike and the closure crib narrowed, the quarry-run material, consisting of one- to two-ton rock, began to be swept away. A string of old pontoon cubes filled with rock was pulled ahead of the fill and sunk in the opening to provide a stabilizing toe as the fill pushed nearer the closure crib unit. Large stone (up to 3-ton size) were used to complete the berm out to the northern crib. This produced a 7-ft head differential on the closure unit.

At this stage of the operation, about three-quarters of the total flow of the South Channel was being diverted through Cut C and the remaining fourth was discharging through the 60-ft gap between the two timber cribs on the closure sled with a velocity of 16 to 20 fps. Heavy steel screens were dropped between vertical beams along the downstream face of this final gap. Trees, cubes, stumps, and 5-ton rocks were dumped into this gap to make the final closure. Once the dike was closed, the berm was quickly built up and widened to reduce possible overtopping. There was a $9^1/_2$-ft head differential on this completed berm. The weather refused to help in this tedious closure—the entire operation was done amid snow squalls and below-freezing temperatures.

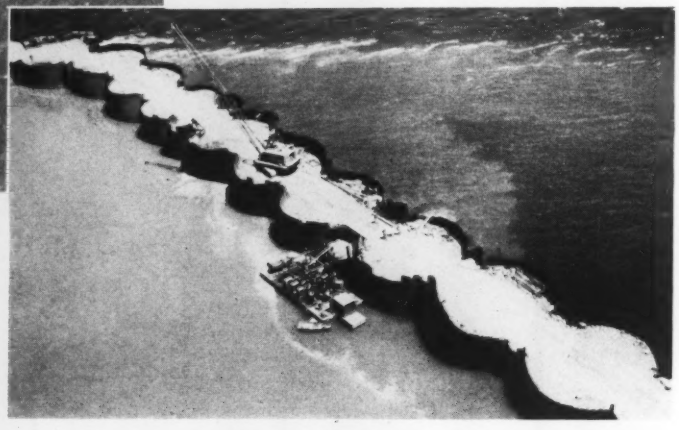
With the temporary dike completed, construction of the 60-ft-dia cells in Cofferdam A, immediately upstream,

Current deflector frame, attached by special connector to completed cell, is lowered by whirler into turbulent waters of Long Sault Rapids. See Fig. 2.

After deflector frame is in place, reinforced concrete bulkheads are lowered between soldier beams which serve as guides. Each bulkhead is 32 ft high, 6 ft wide, and 6 in. thick. Scour removed as much as 15 in. of concrete in places from bottom of bulkheads.



← Completed deflector shield extends for distance of about 50 ft to hold back treacherous currents while sheetpiles for next cell are driven. Velocity head produced by shield was about 3 ft.



Two weeks were required to unwater area enclosed by cofferdams. Total of 540 acre-ft of water was pumped out by nine diesel pumps with combined rated capacity of 15,800 gpm. Area between two cells was used as discharge chamber. Sharp-crested weir was located in outer face of this chamber, and a float recorder continuously measured water head. →

was rushed to completion before the spring breakup of the ice jams in the South Channel.

Cofferdam B moves out into rapids

Simultaneously with the placing of the temporary rock dike, work began on the downstream arm of the cofferdam—Cofferdam B. A C-17 diesel-electric whirler, rated to lift 30-ton loads at a 35-ft working radius, was erected on a rolled impervious fill at the island end of the cofferdam, and started placing the cells of 48-ft diameter out into the rapids.

In placing the first four cells, the usual steps were employed, as follows:

1. A two-ring timber template was positioned by spudding it with four steel beams. This template was framed in two half-circles to facilitate handling.
2. Sheetpiles were set and driven around the template. A boiler erected at the end of the island provided steam to drive the piling.
3. The sheetpiles were set and driven in the closure arcs between the previously completed cell and the new cell.
4. Fill material was trucked from the island gravel pit and clamshelled into the cell by the whirler. The template and spuds were removed as the cell fill reached the water surface.
5. Fill was placed in the arcs between cells and then the whirler tracks were moved ahead to begin the next cell.

The treacherous currents of Long Sault Rapids begin about 200 ft out from the island shoreline, or after four of the cells had been placed by the methods outlined above. Here, surface velocities of 13 fps were observed, striking the centerline of the cofferdam at approximately a 45-deg angle. Plans called for placing seven cells in this rough water before turning the cofferdam toward the mainland. Since it is impossible to set sheeting in such currents, special methods were devised to reduce velocity at each of the seven cell sites.

Current deflector devised

To protect these cells, a special shield was cantilevered out from the previously filled cell to deflect the current away from the site of the next cell. It was then possible to set sheetpiling in comparatively slack water immediately behind the shield, or current deflector. Water depth in the area varied from 18 to 24 ft.

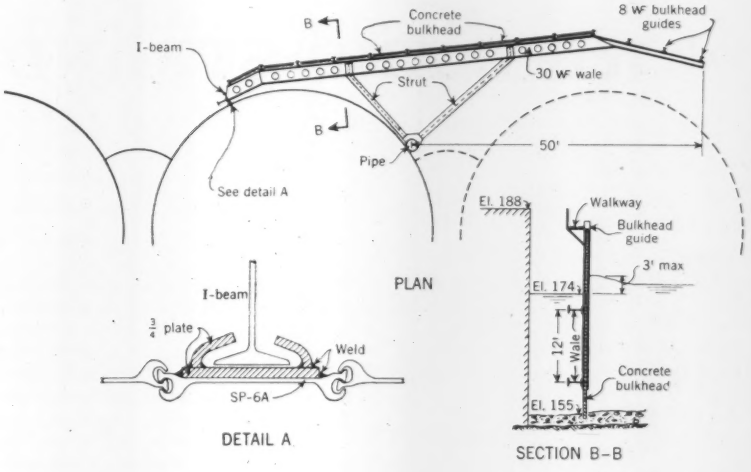
Calculations indicated that the maximum velocity head produced by the swift current striking the shield at a 45- to 50-deg angle would be 3 ft. This head was substantiated by model studies made on varying stages of cofferdam construction by the Hydro-Electric Power Commission of Ontario at its laboratory in Islington, Ontario.

The current deflector, shown in Fig. 2 and in photographs, was designed to resist an assumed parabolic load distribution varying from the maximum velocity head at the end next to the completed cell, to zero at the outer end of the deflector. Field observations later showed that actual loading varied from a 3-ft head differential at the completed cell to a 1-ft head differential at the outer end of the shield. It was also noted that the angle at which the current was striking the deflector decreased with each use. At the last position of the deflector, the current was striking the shield at such a shallow angle (less than 25 deg) that a vortex was created at the outer end, causing a 3-ft differential head in the opposite direction over a localized area at this outer end.

The load of the current deflector was carried in a steel frame 80 ft long with a 35-ton tension connection at the completed cell and compression struts near the middle of the frame carrying a 200-ton compressive load into this same cell. The cantilevered frame extended out approximately 50 ft beyond the edge of the completed cell to shield the area for the succeeding cell. The current was deflected by 13 reinforced concrete bulkheads, each 6 ft wide and 32 ft high, that were dropped into vertical guides, or soldier beams, along the upstream face of the steel-frame unit.

Two horizontal beams, or wales, 12 ft apart made up the steel frame. Large holes were burned in the webs of these wales to reduce the plunging or uplifting force of the water while the unit was being placed. The fixed or cofferdam end of the frame had a vertical I-beam

FIG. 2. Deflector was cantilevered out 50 ft from completed cell as shield to protect site of next cell from current during driving of sheetpiles. Special C-shaped bent plate assembly was fabricated to one sheetpile before driving. Care was taken to keep this special sheetpile plumb in the cofferdam cells. Interlocking I-beam held cofferdam end of deflector frame.



securely fastened to each of the two wales. In placing the frame, the exposed flange of this I-beam blocked into a special C-shaped bent plate assembly (Fig. 2) which, in turn, was shop fabricated to one of the sheetpiles set in the previously completed cell. Care was taken to keep this special pile plumb as the sheets were set and driven. The I-beam on the deflector frame was 35 ft long and distributed the tension load into a sufficient length of the interlocked sheetpile.

The two compression struts near the middle of each wale butted into a single vertical pipe of 24-in. diameter which acted as a crude pivot point for the entire deflector when it was in place against the completed cell. This pipe was strengthened against localized loadings by a neat timber filler.

The 31-ton assembly was handled into position by the C-17 whirler using a six-part pickup line. In placing, the frame unit was kept as level as possible to permit the vertical I-beam to lock easily into the special sheetpile. Two pipe spuds were attached near the outer end of the frame to help support its dead weight when the unit was in position. Placement of the deflector unit was completed with comparative ease.

After this frame was in position, concrete bulkheads 6 in. thick were dropped between the flanges of the vertical soldier beams that had been welded to the upstream face of the frame unit. These bulkheads, weighing 7 tons each, were made by casting concrete between 6-in. steel beams previously welded to the bulkhead reinforcing rods. These beams protected the edges of the bulkheads as they were placed in the guide beams of the deflector frame. In placing them, it was necessary to begin at the end next to the completed cell and work out to the cantilevered end. A walkway, near the top of the soldier beams, provided access for the placement and removal of the bulkheads.

The tremendous force produced by this swift water was shown not only in the head differential developed along the deflector, but also by the astonishing amount of spalling on the bottoms of the concrete bulkhead units. Some of the bulkheads lost as much as 15 in. of concrete along the bottom end as the force of the water shot gravel and small boulders under them.

The current deflector worked well in quieting the water to permit setting of the sheetpiles. With each setting of the deflector, the field crew improved, so that the time taken to place and remove this shield in its final position was cut to less than half that required to perform these operations the first time.

Swift water passing through the South Channel made it impossible to work out from the mainland end of Cofferdam B until the temporary rock dike near Cofferdam A had been completed. Once this dike was in, Cofferdam B proceeded as scheduled, working out from both shores. Closure was made near the bend in the cofferdam arm.

One of the serious problems plaguing the early work on this cofferdam was, again, poor weather. Continual high winds, along with below-freezing temperatures, made pile driving difficult and hazardous.

Unwatering measured accurately

Payment for unwatering the cofferdam was based on the quantity of water pumped during the operation. To measure this quantity, the arc area between two of the cells in the lower arm of the cofferdam was used as a discharge chamber for the pumps. This area was leveled off near the water surface elevation and paved with small riprap to reduce scour. A sharp-crested weir 6 ft long was fitted into the river face of the arc. Near the cofferdam side, a series of baffles was installed to quiet the turbulent water after it had spilled into the discharge chamber from the pumps. Between these baffles and the weir, a float-type automatic recorder kept a permanent record of the head on the measuring weir.

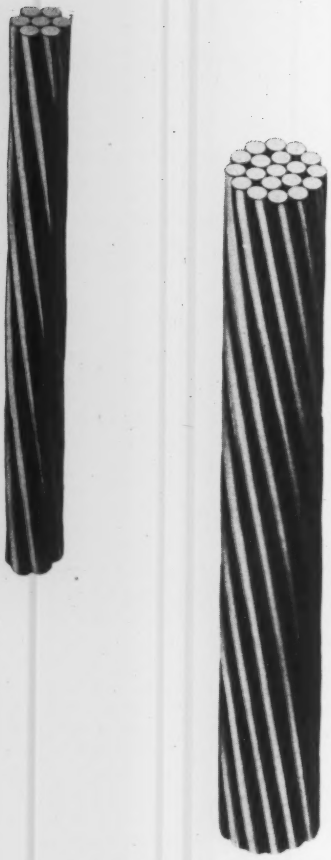
A special barge of 27 pontoon cubes was floated inside the cofferdam to carry the pumps used for the initial unwatering. This pump barge, which dropped with the water surface, carried nine diesel pumps—one 10-in., six 6-in., and two 4-in., with a combined rated capacity of 15,800 gal per min. The discharge pipes of the pumps were elevated and swiveled so that they would discharge directly into the special measuring chamber during the entire pumping process.

Initial unwatering of the cofferdam began on May 31, 1955, and was completed about two weeks later. During this time a total of 540 acre-ft of water was pumped out.

The New York State Fish and Game Commission kept a crew of men at the cofferdam site during the unwatering operation to make sure that the large number of game fish trapped in the cofferdam were carefully seined and released back into the main river.

Seepage and leakage within the pumped cofferdam was surprisingly small. Discharge records show this leakage to be less than 2,000 gal per min (gpm). After the initial unwatering was completed, two holes 10 ft deep were blasted out of the rock floor of the cofferdam to provide sumps for two electric pumps of 2,500-gpm capacity that were installed to handle the permanent pumping of leakage. These pumps were mounted on a special platform above the sumps, and recording flow meters were installed in the discharge line of each to measure the quantity of leakage water pumped.

WIRE AND STRAND



Two types of strand are discussed in this article. At left is 7-wire uncoated strand of type used for pretensioned, bonded work. At right is galvanized strand such as is used in post-tensioning, of 1-in. diameter, with 19 wires.

H. KENT PRESTON, M. ASCE

Engineer, Construction Materials Division, John A. Roebling's Sons Corporation, Trenton, N. J.

Every prestressed concrete tensioning element should have certain properties, namely:

1. High strength, to minimize the percentage of stress loss due to such factors as shrinkage and plastic flow.
2. Low coefficient of creep.
3. Ease of handling. Not only do cranky wire and strand add considerably to the contractor's costs, and therefore to his selling price, but the rough handling necessary to fight them into place often leaves them nicked, kinked, or otherwise permanently damaged.
4. Good surface for bonding to concrete on uncoated tendons.
5. Sufficient ductility, and uniform modulus of elasticity.
6. Resistance to stress-corrosion.

The wire referred to in this article is high-strength uncoated stress-relieved wire made specifically for use in prestressed concrete. The uncoated strand discussed is the 7-wire stress-relieved strand made specifically for use in pretensioned, bonded prestressed concrete. The galvanized strands for post-tensioning are the type that has been used in suspension bridges for over half a century except that the end connections have been adapted to prestressed concrete.

Wire is made by rolling steel billets into round rods and then drawing the rods through conical dies to produce the required size and strength. The drawing operation reduces the diameter and increases the length. It also changes the internal structure from the crystalline make-up of the rod to the long fibers parallel to the axis which give wire its great strength. As it emerges from the last die, the product is referred to as "cold-drawn" wire.

Wire for use in prestressed concrete is made by subjecting cold-drawn wire to a stress-relieving process. Stress-relieving is not what we usually think of as a heat treatment; the temperature used is not sufficient to change the strength of the wire but it does eliminate the internal stresses which are

FOR PRESTRESSED CONCRETE

present in the wire as a result of the drawing process.

The uncoated strand discussed here is composed of seven cold-drawn wires fabricated by laying six wires of one size around a slightly larger center wire. In this case the finished strand is subjected to the stress-relieving operation which eliminates at one time the internal stresses due to both the drawing and the stranding operations.

Uncoated wire and 7-wire strand

Creep and relaxation. Numerous studies have been made on the subject of creep and relaxation in wire. Creep is the gradual non-elastic increase in the length of wire under a constant tension. Relaxation is a gradual loss of stress in a wire held at constant length. In a prestressed concrete member, the wire undergoes a modified form of relaxation; that is, the concrete member shortens as a result of its own shrinkage and plastic flow so that the wire is not held at a constant length but shortens with the concrete. Thus, the test values measured for relaxation in wire indicate slightly more stress loss than this factor actually causes.

Creep and relaxation properties of cold-drawn wire, stress-relieved wire, and mechanically straightened wire have been compared in as many different ways as possible. Mechanically straightened wire does not measure up—unless it is stress relieved after straightening—in which case it is in the same class with stress-relieved wire. Although these properties of stress-relieved wire are slightly better than those of cold-drawn wire in the stress ranges in which they are used, the difference is so small that the two materials can be considered as having the same creep and relaxation. In considering this subject, the designer should not lose sight of the fact that a change in the density of the concrete due to more or less vibration, or a slight error in keeping to the specified water-cement ratio, can cause a change in stress loss several times any difference that can be found between the two types of wire.

Preloading. Some designers feel that preloading wires—holding them at a tension above the specified initial tension for a few minutes before anchoring them at the specified tension—is advantageous.

It is probable that this impression stems from European practice which is explained by the report in the late Gustav Magnel's book, *Prestressed Concrete*, in which he discusses the wire used in Belgium. This wire, of 5-mm (0.196-in.) diameter, has an ultimate strength of 216,000 psi. It is used at an initial tension of 123,000 psi, but its stress-strain curve begins to bend quite sharply away from a straight line at two-thirds of this stress. His tests showed a stress loss of 12 percent in the wire alone when used at an initial tension of 123,000 psi. When preloaded to 137,000 psi for two minutes, and then anchored at 123,000 psi, this loss was reduced to 4 percent. Obviously it pays to preload such a wire, especially when the preload required is only 63.5 percent of the ultimate strength of the wire.

The stress-relieved wire of 0.196-in. diameter used for prestressed concrete in the United States has an ultimate strength of 250,000 psi. Most designers use it at an initial tension of 67 percent of its ultimate. At this stress, the stress-strain curve of the stress-relieved wire is still a straight line. Tests on this wire show a maximum stress-loss of less than 4 percent from the initial 67 percent. The Bureau of Public Roads' "Criteria for Prestressed Concrete Bridges" assumes a 4-percent loss due to creep in the steel, and considers that "over-stretching" is not necessary.

Tests made at Roebling's Trenton plant show less stress-loss in a wire which has been preloaded than in one which has not, but these tests cover only a relatively short period of time. DeStrycker has studied creep of wire over a period of years (*Revue de Métallurgie*, Oct. 1948, p. 411). In his tests he preloaded the wire by 10 percent for two minutes. His results indicate less loss in the preloaded wire at first, but the difference between the two procedures after several years is negligible. The results obtained by preloading stress-relieved strands are identical with those obtained by preloading stress-relieved wire.

In the final analysis, the increase in final tension obtained by preloading the high-quality wire used in the United States is so small that it cannot be applied to reduce the amount of wire in a member. On the other hand, the contractor will definitely increase his price when this operation is required in the specifications.

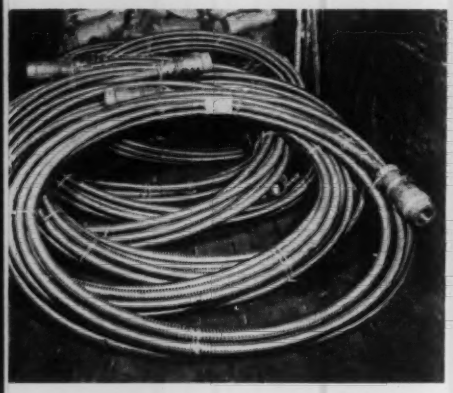
Fatigue. As with any material, the stress range through which a wire can stand repeated loadings decreases as the stress increases. Using the initial stresses recommended later on, the minimum final stress in both wire and strand will be 58 to 60 percent of the ultimate. Data already available demonstrate that fatigue is not a problem on these wires and strands in this stress range. If higher stresses are contemplated, a thorough investigation of fatigue under such stresses should be conducted before they are permitted.

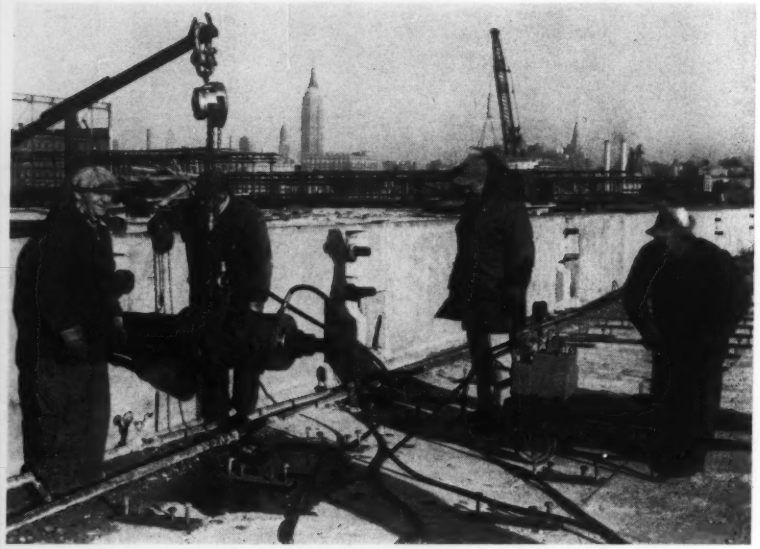
A review of European specifications for post-tensioned members compiled in 1952 shows initial tensions of 50 to 60 percent of the ultimate. Taking advantage of the superior elastic properties of the stress-relieved wire available in the United States, designers using this wire are specifying an initial tension of 67 percent of the ultimate. Ultimate strength varies with wire size but is in the neighborhood of 250,000 psi.

Although an initial tension of 67 percent is desirable, there are several reasons why we should not design to initial tensions in excess of 70 percent:

1. Common sense says we should not approach the ultimate too closely as there are other factors which may create

Galvanized strands of 1 $^{9}/_{16}$-in. diameter encased in flexible metal hose of 1 $^{13}/_{16}$-in. inside diameter, are coiled and loaded in truck for shipment. Sockets for end anchorages are tapped for permanent stud, which will be applied in the field.





Long-stroke center-hole ram tensions strand of 1 $^{9}/_{16}$-in. diameter in post-tensioned pile cap of Pier A, Hoboken, N. J. Note New York skyline in background.

stresses higher than anticipated. For instance, many cables must be over-tensioned to overcome friction between wire and concrete.

2. As the initial tension increases beyond this point, the percentage of stress loss increases much more rapidly. This means a greater differential between the initial and final tension conditions. Engineers familiar with prestressed concrete design realize that the larger this differential becomes, the less efficient may be the design of the prestressed member.

3. All members must meet both a design load and an ultimate-strength specification. Excessively high stresses in the prestressing steel reduce its quantity and lower the ultimate strength of the member. This often necessitates extra steel to meet the ultimate strength requirement.

4. Fatigue stresses may become a factor.

Initial tension in strand. A review of European specifications for pre-tensioned members compiled in 1952 shows initial tensions of 60 to 70 percent of ultimate. It should be noted that all the tensioning elements were single wires, which cannot be used in the United States for economic reasons—because of the high labor cost of handling so many small units and the need to use small aggregate so that the concrete will flow around the many tensioning elements.

An initial tension of 70 percent of the ultimate is recommended for 7-wire stress-relieved prestressed concrete strands used in pretensioned bonded members. Ultimate strength varies with strand size but is in the neighborhood of 250,000 psi. In addition to the four reasons mentioned above, there are several other reasons for using the 70-percent value:

1. The stress loss in a pretensioned member is greater than in a post-tensioned member because all the elastic compression and some of the shrinkage are eliminated by post-tensioning but not by pretensioning. The final stresses resulting from initial tensions of 67 percent for post-tensioned members and 70 percent for pretensioned members are about the same.

2. Initial tension can be specified as high as it is safe to tension the strand since it will never be necessary to over-stress the strand to overcome friction or for any other reason.

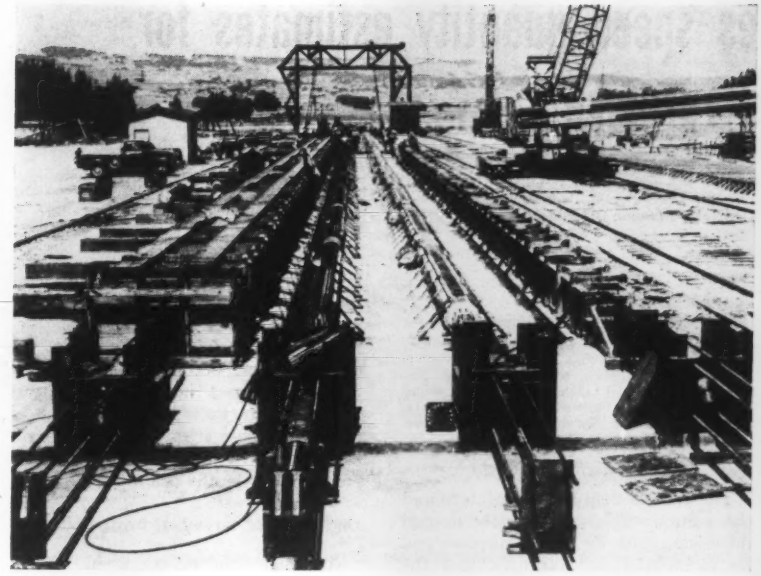
Stress-relieved materials. From the designer's point of view, stress-relieved wire and strand have several advantages over the cold-drawn materials. For instance, they have several times as much resistance to stress-corrosion; the stress-relieving process removes the wire-drawing lubricant, providing a better bonding surface; and the stress relieved materials have a much more uniform modulus of elasticity. When a group of such wires or strands is tensioned at one time, the stress in each will be the same and the elongation can be used to check the load. Finally, the cold-drawn materials are cranky and hard to handle. This results in rough handling by the erectors and the material is sometimes damaged by the time it is in place.

All prestressed concrete fabricators in the United States insist on stress-relieved wire because of the difficulty of handling cold-drawn wire. If cold-drawn wire were specified, the fabricators' cost would increase considerably (if they felt they could do the job at all) because of the extreme difficulty of handling this material.

Galvanized strand

Galvanized strands prove most economical where the tensioning elements are long, where the prestressing force is large, or where rust or corrosion is a consideration.

Wire for these strands is made by passing high-strength cold-drawn wire through a bath of molten zinc. The result is a thoroughly stress-relieved wire protected by an outer coating of pure zinc, plus a hard zinc-steel alloy between the zinc and the wire. Although the zinc is a protective coat-



Prestressed concrete casting yard, operated by Ben C. Gerwick, Inc., at Petaluma, Calif., makes pretensioned bonded piles.

ing which carries no load, it is standard practice in the wire industry to refer to the overall diameter of the wire including the zinc and to use the gross cross-sectional area including the zinc. On this basis the minimum ultimate strength of the wires is 220,000 to 225,000 psi, although the strength of the steel, which is carrying all the load, is appreciably higher.

Galvanized strands for prestressed concrete are made by laying one or more layers of wire around a center wire. Most of the wires are of 0.196-in. diameter, supplemented by a few wires of other sizes to get the required overall diameter and strength. Standard sizes range from 0.600 to 1 $^{11}/_{16}$-in. diameter, with minimum ultimate strengths varying from 46,000 lb to 352,000 lb per strand.

Although the individual wires have been stress-relieved by their passage through the molten zinc, the finished strand as it comes from the stranding machine does not necessarily have a constant modulus of elasticity. It is given a constant modulus by a prestretching operation in which it is held at a high stress for a period of time during which the individual wires adjust themselves to each other.

End anchors, referred to as fittings, are attached at the manufacturer's plant so that the strands arrive on the job ready to be placed in the structure. Several styles of fittings are available. One has a permanent stud the length of which can be varied to suit the details of the particular job. A jacking unit is attached to the end of the stud for the tensioning operation, and a permanent nut on the stud holds the load after jacking is completed. If it is in the way, that part of the stud outside the nut can be burned off after tensioning has been completed.

Another type of fitting is threaded on the outside and has a large nut to hold the load. It is also tapped to receive a jacking rod which is removed after the tensioning operation. The thread on both types is long enough to allow for reasonable errors in the length of the concrete member. A third type of fitting is a steel casting with a wide flange on the end which serves as a bearing plate. For most strands this fitting is cheaper than one with threads, and it eliminates the need for a bearing plate. The concrete is cast directly around this fitting and the tensioning is done from the opposite end, which is provided with a threaded fitting for the purpose.

Galvanized strands are used in several ways for post-tensioned members—in the open space in a concrete hollow-box, on the outside of a concrete member, or encased in a paper or plastic tube to prevent bond and covered by the concrete as it is poured. When grouting is required, strands are supplied encased in flexible metal hose, which is filled with grout after the jacking operation.

Creep and relaxation. The percentage of stress loss due to relaxation in a galvanized strand is approximately the same as that in a parallel wire cable. The initial stress is lower—140,000 psi compared to 167,500 psi—but the modulus of elasticity is also lower in almost the same ratio—25 million psi to 29 million psi—so that the two factors cancel each other.

Fatigue. Galvanized strand assemblies with fittings attached have been subjected to fatigue loadings as separate assemblies, in prestressed concrete test members, and in service in forging hammer foundations. There has never been any evidence of damage to the assembly due to such loadings. These strands are generally designed for an initial tension of 140,000 psi.

Desirable properties. Galvanized strands have several desirable properties which should be considered when the tensioning elements for a project are being selected:

1. A minimum amount of field labor is required for placing and tensioning. Regular job personnel can handle both placing and tensioning without special supervision. Long lengths are as easy to handle as short lengths because they can be supplied on reels.
2. The corrosion problem is virtually eliminated. A galvanized suspender recently removed from the Brooklyn Bridge for test after sixty years of service was found to be in satisfactory working condition.
3. Galvanized strands can be left exposed to the weather where uncoated tendons have to be protected. If grouting after tensioning is required, and the tendons will first be exposed to the weather, a galvanized flexible metal hose can be used and the entire assembly will be rustproof.
4. Galvanized strands can be tensioned more accurately to specification requirements than uncoated tendons. The coefficient of friction for the galvanized strand is much lower and quite uniform, whereas this value for uncoated tendons becomes increasingly higher as surface rust develops during the curing period of the concrete. This is of extreme importance in long or continuous structures, since high and nonuniform friction values result in varying tension throughout the length of the tendon. Galvanized strands assure much greater uniformity in this respect.

Seismic profiles speed quantity estimates for Massachusetts Turnpike

VINCENT J. MURPHY

Geophysicist, Geophysical Survey Division, Gahagan Dredging Corporation, New York, N. Y.

Subsurface exploration is complete and construction is well under way along the entire route of the 123-mile Massachusetts Turnpike. This new $239,000,000 superhighway will extend from Circumferential Highway Route 128, at Weston, Mass., its eastern terminus, to the New York Thruway at the state line, its western terminus. It will expedite automobile and truck traffic between the Greater Boston area and points west and south of Boston.

Massachusetts is an area of complex geology, in part the result of intense glaciation. Changes in the lithologic facies of the overburden are numerous, and glacial scouring as well as preglacial differential erosion has resulted in a most uneven bedrock surface. This highly irregular bedrock surface is the bane of engineers if they are compelled to interpolate and extrapolate subsurface conditions from the results of a few borings in any proposed highway cut. It was therefore highly desirable to supplement the borings with another method of subsurface investigation.

With this idea in mind, the Massachusetts Turnpike Authority entered into a contract with the Geophysical Survey Division of the Gahagan Dredging Corporation of New York to make seismic surveys in certain sections of the proposed Turnpike route. The areas selected for seismic investigation were primarily those in which the depth of cut would warrant the use of the seismic technique in addition to borings. Obviously, areas where the cut would be very shallow or where bedrock was extensively exposed, were not included in these operations.

Seismic field operations were performed in collaboration with the general Consulting Engineers, Howard, Needles, Tammen & Bergendoff, and the various Section Engineers. Since it is not the purpose of this article to discuss the theory of the seismic refraction method, the reader is referred to the following articles and texts for such information:

"Application of Geology and Seismology to Highway Location and Design in Massachusetts," Bulletin 13, Highway Research Board, 1948.

"Practical Seismology and Seismic Prospecting," L. D. Leet, D. Appleton-Century Co., 1938.

"Seismology Applied to Shallow Zone Research," Rev. Daniel Linehan, S.J.: Symposium on Surface and Subsurface Reconnaissance, Special Tech. Pub. No. 122, American Society for Testing Materials, 1951.

Seismic data urgently needed

The general consulting engineers and the section engineers urgently needed the seismic data for design purposes and for estimation of quantities, and the degree of urgency can be appreciated from the fact that completion of the entire Turnpike is scheduled for November 1956. Furthermore, the date of advertising the first bid for construction was November 21, 1954, and seismic field operations did not begin until August 9, 1954. This limited time factor made it necessary to place several seismic crews in the field at one time.

Generally speaking, lines of investigation were run along the Turnpike centerline and approximately 50 or 65 ft to the left and right of it. These left and right lines generally coincided with the proposed position of the outside edges of the Turnpike roadways. Ordinarily seismic spreads 200 ft long were set out so that the last geophone of any spread was in the same position as the first geophone of the next spread, thus effecting what is known as a seismic tie-in. In some areas the seismic depths to rock along the centerline were considerably greater than the depth of the highway cut. For this reason the left and right lines were sometimes eliminated and a few transverse spreads were laid out to complete the general bedrock picture.

The three continuous seismic profiles parallel to the route of the Turnpike were deemed the most economical and practical coverage for each cut area. This single factor of continuous profiling is one of the most advantageous aspects of the seismic technique. While it is true that minor depressions and minor rises in the rock surface are not detected by the seismic method, it must be remembered that the depths to rock indicated on seismic data profiles are average depths and are therefore most suitable for general design and quantity estimation. With this advance information regarding depths to rock, the engineers were better able to establish boring programs in areas of critical depth and to decrease the number of borings in those areas where seismic results indicated that the rock was at considerable depths below grade.

Under-water survey at bridge site

Although the investigation of cut areas comprised the major part of the seismic operations, investigations were also conducted at the sites of two major bridges. At one of these, the Westfield River Bridge site, seismic data were needed to complete the engineers' bedrock profile, previously deduced from borings and geologic studies. This was accomplished by indicating depths to rock beneath the land section of the bridge and also beneath the river.

For the under-water part of the survey, in the swift current, it was necessary to use a different type of geophone from that used in land operations, the narrowness of the river made it possible to set up the recording instruments on land and to use small rowboats from which the members of the field crew planted the under-water geophones. If the water had been shallower, the crew could have waded into the stream to plant the geophones, and boats would not have been required.

In addition to the under-water part of the survey at this major bridge site, two land profiles were taken parallel to the centerline of the bridge approach on one side of the river. Borings were also taken—before and during the seismic operations. It was hoped that the seismic data would not only complement the borings but also indicate any unusual subsurface conditions undetected by the borings. At one point, the seismic profile made it possible to reinterpret the boring log. Initially it appeared that a boring had encountered rock at a depth much shallower than that shown by the seismic data. However, further inspection of the boring log indicated that, at a depth corresponding to the seismic depth to rock, the drill had cored solid

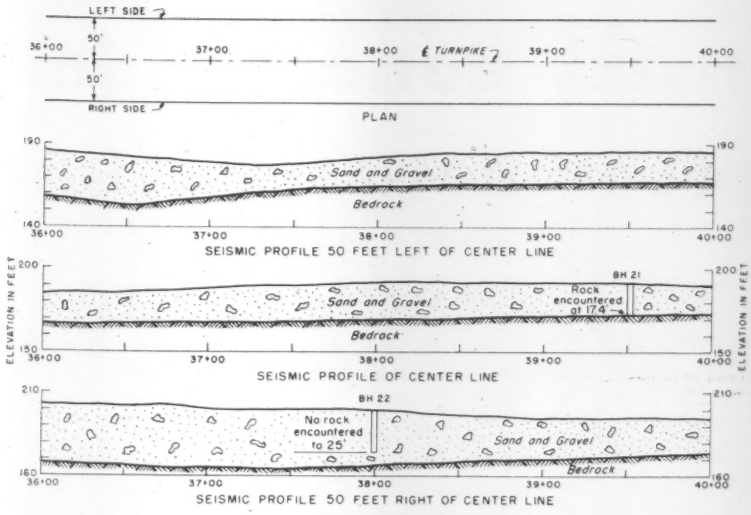


FIG. 1. Continuous profile in one vertical plane is typical of subsurface information obtained by seismic methods for cut sections on 123-mile Massachusetts Turnpike.

Members of Gahagan survey crew record seismic data in four-wheel-drive station wagon specially outfitted. Data are picked up by cable from geophones over a 200-ft "spread." At some sites it was necessary to hand-carry recording instruments along survey route.

Under-water geophones are placed across narrow river. At this site it was possible to set up recording instruments on land.

bedrock, making it probable that the material encountered above that point was a boulder or extremely weathered rock.

Because of the urgent need for the seismic data, the engineers could not wait for the submission of Gahagan's formal, comprehensive report. Therefore in many instances final results were submitted in preliminary form within a day or two of the actual field operations.

A variety of operating conditions was encountered by the field crews. The rugged terrain of the Berkshire Hills contrasted with the rolling lowlands near the eastern terminus of the highway. Summer heat and sub-zero winter conditions added to the diversity. For ease of operation, the seismic instruments were mounted in vehicles with four-wheel drives—station wagons and light trucks. The instruments were enclosed in aluminum suitcases of standard size, and were fully portable even to sites that were inaccessible to the four-wheel-drive vehicles. This factor of complete portability enabled the four-man Gahagan crews to operate in areas far removed from roads and trails.

Frozen ground complicates work

The winter of 1954–1955 saw only a small amount of snow accumulation, and the absence of this natural insulating material increased the depth of ice and frozen ground. In one area the frozen stratum was approximately 4 ft thick. This frozen layer is actually a distinct geologic stratum separate from the overburden beneath it, and frequently the seismic wave speeds through the frozen layer faster than it does through the non-frozen overburden. Thus the seismic waves arriving from strata beneath the ice are masked by the ice effect. This is known as an inverse velocity phenomenon. Despite this handicap, operations proceeded successfully during the winter months.

Field operations began on August 9, 1954, and ended on May 4, 1955. Approximately 4,000 seismic shots were fired, resulting in some 45,000 instrument readings. The seismic results computed from these readings, and presented in profile form, enabled the section engineers to construct more than 1,400 cross-section profiles at 50-ft intervals, as shown in Fig. 1.

At present a major part of the excavation has been completed in the 56 seismic areas, ranging from a few hundred to a few thousand feet in length. Results reported to date have been satisfactory. A partial measure of the accuracy of the method is provided by the borings. Generally speaking, the boring data checked with the seismic data within 2 ft, and some borings made subsequent to the seismic operations checked within 2 in.

Prior to excavation, borings are the only measure of the accuracy of the seismic method. This is not a complete measure because the comparison is between two entirely different methods of investigation. Borings are strictly localized and vertical in nature. Seismic exploration is both horizontal and vertical, that is, it is a continuous vertical profile. While one method indicates conditions at a point, the other indicates conditions in a vertical plane. Thus it is for the individual to decide which type of exploration, pin-point or areal, is best suited to his needs. Often, as was the case with subsurface investigations for the Massachusetts Turnpike, the use of seismic data combined with boring data results in the most economical and practical exploratory coverage for a civil engineering enterprise.

High-density concrete for reactor construction

HAROLD S. DAVIS, A.M. ASCE

Reactor Design and Development, Engineering Department, General Electric Company, Richland, Wash.

The erection of a concrete biological shield at Hanford, Wash., presented several unique construction problems. This shield encloses the radioactive core of a reactor and is designed to protect operating personnel from the harmful effects of pile neutrons and associated gamma radiation. Permanent steel forms were erected to close tolerances around the reactor and filled with high-density concrete by the Intrusion-Prepakt method. Prefabricated sections of the steel forms, or crates as they were called, weighed up to 18 tons each.

During erection, the process holes through successive crates were kept within 0.012 in. of their nominal distances. The left side, the top, and the right side of this biological shield were constructed integrally to form a rigid frame. See Fig. 1. The front and rear crates, which contain numerous process holes, were keyed into the side and top shields to permit relative expansion of shield components and to provide for their lateral support. These massive steel and concrete walls provide considerable resistance to blast and earthquake forces, support numerous process facilities, and contain pile gas, as well as protect personnel from nuclear radiation.

High-density concrete

Three types of high-density concrete were developed especially for this job—prepacked concretes and one conventional concrete. They contain an optimum amount of retained water in order to improve their shielding ability for attenuating pile neutrons. Limonite-goethite ore, a hydrous iron ore, was used both as coarse and fine aggregate because of its high content of crystallized water and its high density. In critical sections of the biological shield, coarse aggregate consisting of steel punchings and limonite-goethite ore were placed in the forms and compacted to the specified unit weight. Magnetite ore, an iron oxide of high density, was used instead of expensive steel aggregate in certain sections of the shield where high density was not required. A special heavy grout was then pumped into the bottom of the forms under a 2-ft head of water until all the voids in the heavy aggregate were filled completely with grout. The composition and density of the concretes used in the construction are given in Table I.

This method of placing high-density concrete minimized segregation of coarse aggregates and permitted close control of density and composition. The Prepakt method avoided some of the difficulties of placing premixed concrete containing steel punchings around embedded tubes and in restricted areas, and assured the desired uniformity and density. However, care in selecting and processing heavy aggregates, close control of aggregate blending and compaction, and proper supervision of grout mixing and pumping, all contributed to the successful completion of the work.

Procuring heavy aggregates

Descriptive data on heavy aggregates are summarized in Table II. The steel, limonite, and magnetite aggregates procured for this job were some of the best obtainable. Limonite-goethite ore ($Fe_2O_3 \cdot NH_2O$), referred to below as limonite, is an excellent material for slowing down and thermalizing neutrons because of its high water and iron content. Magnetite (Fe_3O_4) was used because it was the heaviest and cheapest type of aggregate available at Hanford. Care was taken in selecting sources of heavy aggregates in order to obtain sound materials suitable for use in concrete.

No difficulty was experienced in obtaining approximately 3,800 tons of graded coarse magnetite. However, certain problems arose during the procurement of dense limonite because of its limited availability. Western limonites usually occur in small sporadic deposits, are lower in density than ore from Michigan, but contain 20 percent more fixed water of crystallization than does the Michigan ore. A total of 5,700 tons of limonite ore were obtained from a western vendor before his deposit was depleted. This mine-run ore contained substantial amounts of fines and porous material as well as dense limonite, and required careful processing at Hanford in order to produce suitable $^3/_8$- to 1-in. coarse aggregate. The grout sand processed from this limonite produced a grout of excellent quality, having a density of 147 lb per cu ft.

From a mine in Michigan an additional 2,000 tons of limonite were obtained. This ore was screened at the source, and only the plus $^3/_4$, minus 8-in. material was shipped to Hanford. There it was crushed to produce $^1/_2$- to $1^1/_2$-in. coarse aggregate. By not shipping the unwanted fine ore to Hanford, an estimated $60,000 were saved in freight and limonite charges.

Steel aggregate was purchased from around Denver and San Francisco at a cost of about $120 per ton, and shipped to Hanford, making its total cost $140 per ton, FOB Hanford. It consisted primarily of sheared bar stock and some punchings, with a specific gravity of 7.75, ranging in size from $^1/_2$ to 1 in. and from $^1/_2$ to $1^1/_2$ in. When blended with 1-in. maximum limonite, the smaller size of steel aggregate was used in restricted areas of the shield. In general, pieces of steel aggregate were cubical in shape, clean, and relatively free of thin or elongated pieces of steel. Steel aggregate, as well as limonite and magnetite, was obtained on the basis of competitive bids.

Three-deck screening plant and cone crusher process limonite aggregate for heavy-concrete reactor shield at Hanford. Mine-run ore in background is passed through primary jaw crusher and a roll crusher. Conveyor in foreground moves $^3/_8$- to 1-in. material to stockpile at left. Magnet suspended over top of conveyor belt (center) removes steel punchings inadvertently mixed with limonite.

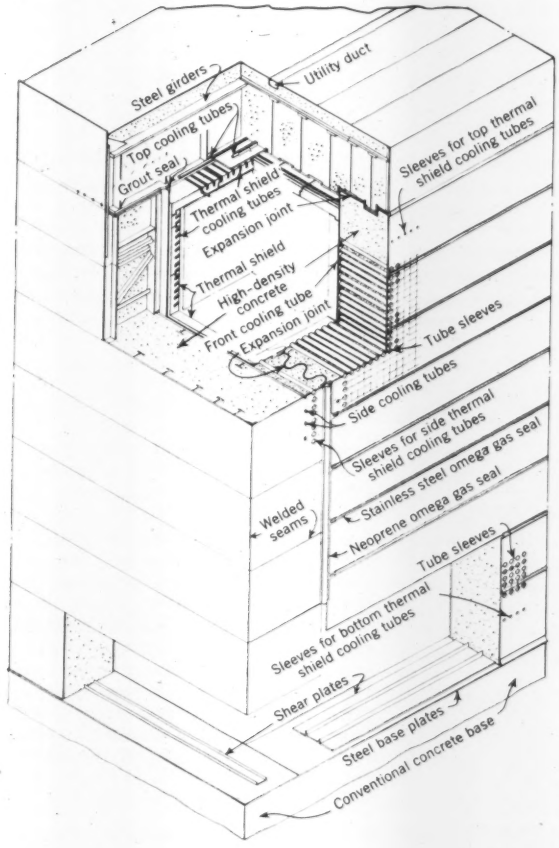


FIG. 1. Isometric drawing of reactor shield shows arrangement of side and top shields in which the heavy concrete here described was placed.

TABLE I. Composition of high-density fill in reactor shield

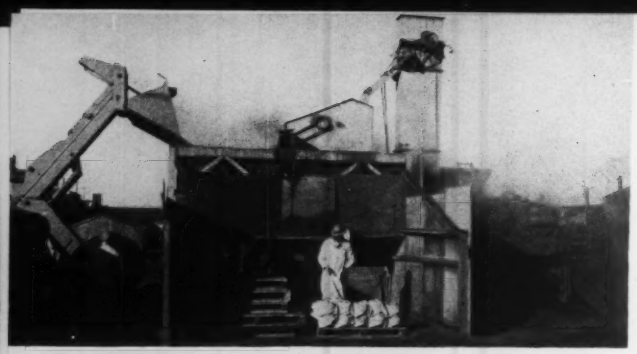
Item	Mix No. 1	Mix No. 3	Mix No. 6
Placement method	Prepacked	Prepacked	Conventional
Coarse aggregate, 1 or $1^1/_2$ in. max.	Steel & limonite	Magnetite & limonite	Magnetite
Fine aggregate	Limonite grout sand (−No. 16)	Limonite grout sand (−No. 16)	Limonite sand (−No. 4)
Unit weight, lb per cu ft (dry-packed aggregate)	210 to 225	150 to 160	....
Wet density, lb per cu ft	265 to 275	205 min	205 min
Min wet density of grout, lb per cu ft	142	142	....
Min water retained in concrete at 85° C, lb per cu ft	13	12	12

Note: Grout consists of 120 parts of sand and 94 parts of Type II portland cement by weight, with a water cement ratio of about 0.55.

In general, heavy aggregates were sufficiently strong, sound and clean to produce concrete having a 28-day strength in compression of at least 3,000 psi. For detailed information see paper, "Properties of High-Density Concrete Made with Iron Aggregate," by H. S. Davis, F. L. Browne, and H. C. Witter, in *Journal of American Concrete Inst.*, March 1956.

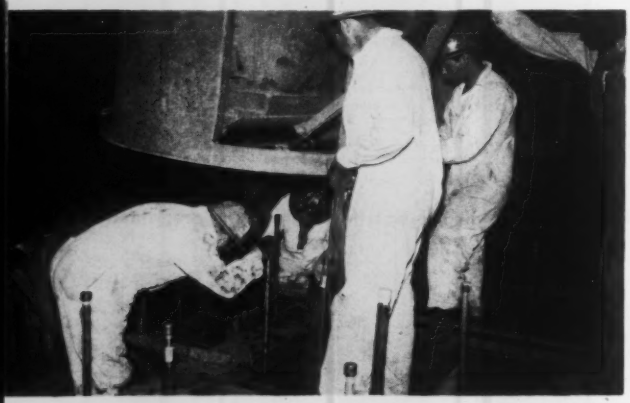
TABLE II. Physical properties of heavy aggregates

Source	Limonite from Utah	Limonite from Mich.	Magnetite from Nev.
Natural ore			
Percentage iron (Fe)	54.5	58.3	63.5
Percentage silica (SiO_2)	5.9	3.2	3.7
Fixed water at 100 deg C, %	11.0	9.0	1.5
Coarse aggregate			
Specific gravity (SSD)	3.46	3.75	4.62
Unit weight, dry and rodded	118	134	167
Absorption, %	3.30	2.9	0.5
Percentage retained on U.S. Stnd. sq. screens:			
$1^1/_2$ in.	0	1	2
$1^1/_4$ in.	0	12	10
1 in.	0	43	37
$^3/_4$ in.	45	76	61
$^1/_2$ in.	87	96	90
$^3/_8$ in.	98	99	95
Coef. of expansion, in. per in. per deg C (10^{-6})	6.1	5.4	..
Specific heat, BTU per lb per deg C	0.19	0.19	..
Chemical reactivity with sodium hydroxide	Innocuous	Innocuous	Innocuous
Fine aggregate			
Specific gravity (SSD)	3.71	3.75	4.50
Fineness modulus	1.19	2.05	1.15
Percentage retained on:			
No. 16 screen	0	25	0
No. 100 screen	64	79	67
Procurement data			
Cost F.O.B. Hanford	$19.75	$25.58	$16.18
Condition	Mine run	Screened	Crushed
Size, inches	0 to 16	$^3/_4$ to 8	$^1/_4$ to $1^1/_2$

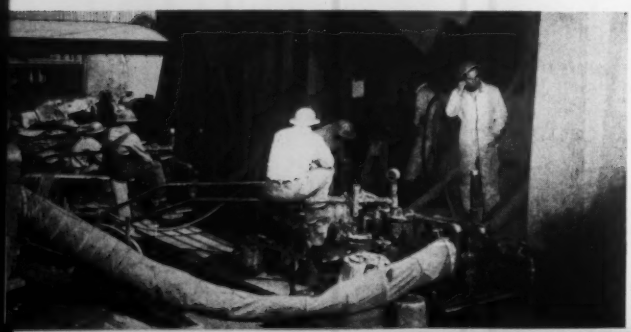


Hammer mill and ball mill reduce minus $^3/_8$-in. limonite chips to grout sand. Front-end loader, two-compartment bin, and conveyor are seen in action. Sand is sacked in carefully weighed 60-lb bags for handling on pallets.

Here steel punchings and bar ends are blended with limonite and magnetite aggregate. Ore is washed in bins out of photo at left, conveyed separately to storage bins at center, weighed and mixed together in mixer just to right of center, elevated in tower at right, passed over $^3/_8$-in. vibrating screen, discharged into buckets, and hauled by truck to reactor site.



Aggregate is placed in top shield of reactor by discharging it from bucket. In lower parts of forms, it was dropped through elephant-trunk to reduce breakage and segregation, and to prevent displacement of inserts. Next, aggregate will be moved into place with pneumatic tampers and compacted. Note $^3/_4$-in. pipes through which grout will be injected.



Grout mixing and pumping plant, located about 200 ft from shield, pumps thick grout, made from limonite sand, for placing at rate of 4 cu yd per hour. Grout weighs 147 lb per cu ft.

Aggregate processing and blending

Limonite aggregates were crushed and processed in a plant set up by the Lake City Gravel and Materials Company, a subcontractor of Kaiser Engineers. Limonite chips, which passed a $^3/_8$-in. screen after going through the cone crusher, were processed into grout sand, then weighed and sacked in 60-lb bags and transported on pallets. Processed coarse aggregates were stockpiled on concrete slabs, while the bagged sand was stored in sheds until used in order to prevent contamination by foreign materials. The aggregate and grout-sand plants are shown in accompanying photographs.

Specifications require that coarse aggregates consisting of steel aggregate and limonite (or magnetite and limonite) be blended together, mixed uniformly, and placed in the forms without appreciable amounts of segregation and aggregate breakage. A clamshell bucket was used to transport heavy aggregate to washing bins. Puddling of limonite and magnetite with water was sufficient to remove fine material and surface dust. Steel aggregate was not washed before batching.

Aggregates were stored and weighed separately in the three-bin batcher. A half cubic yard of steel and limonite, or a full cubic yard of magnetite and limonite, were batched at a time and then mixed together in the portable concrete mixer. The mixer was filled partly with water to minimize aggregate breakage and turned over a few times before its load was discharged into the skip hoist bucket. Water drained away through holes in the discharge top of the mixer and through holes in the skip hoist bucket. The wet aggregates were then elevated and passed over a $^3/_8$-in. vibrating screen to remove the remaining fines before being dumped into concrete buckets and hauled to the reactor site.

Although the batching and handling of aggregates while they were wet presented certain control problems, the blending method used proved satisfactory for mixing aggregates, removing fines from the blended aggregate, and for eliminating dust during handling and placing in the forms. Segregation of steel punchings was reduced by baffles in all buckets, which deflected the steel punchings to the sides of the bucket

rather than letting them pile up in the center. Unit weights of representative samples of blended aggregates from each bucket were determined just before placing in the forms.

Placing aggregate in the forms

Heavy aggregates were placed in the forms in uniform layers up to 6 in. deep and then compacted to a void content of 40 to 44 percent. Aggregates were dropped through an "elephant trunk" as near as possible to the desired location in order to minimize aggregate segregation. As required to fill restricted areas and corners, aggregates were moved and compacted with the aid of pneumatic tampers.

Since it was desired to reduce compressive stresses on the inside faces of the shields on the left and right sides, the top girders were supported near the outside edges of the side shields, and the center section of the top shield was filled with heavy aggregates before the ends of the girders were welded to the side crates. Heavy aggregates were placed in the crates and top shield at an average rate of 3 cu yd per hour. The rate of aggregate placement varied from about 2 cu yd per hour for the front and rear crates, to over 4 cu yd per hour for less restricted areas of the side crates and top shield. The location and alignment of embedded items were checked before the aggregates were solidified with heavy grout.

Since limonite and magnetite aggregates are rather brittle, the type and amount of compaction had to be controlled carefully to minimize aggregate breakage and segregation, and still compact the aggregate to the desired density. The void content of the Prepakt aggregates was determined by metering the water while it was being pumped into the crates before and after the placement of aggregates. The values for void content were found to check closely with the values computed from the number of buckets and the weight of aggregates placed in the respective crates.

Construction techniques

From a grouting standpoint, it would have been more desirable to solidify the aggregates in one whole side shield during one pumping operation, but primarily because of alignment problems, it was necessary to pump only one crate at a time. The normal sequence consisted of aligning a rear crate, placing grout insert pipes and reinforcing steel, filling the crate with heavy aggregate, and then pumping in the limonite grout. As soon as the rear crate was in position, the next front crate was aligned, followed by corresponding crates on the left and right sides. Thus work progressed around the shield, one tier at a time. Working three shifts a day, a tier of four crates could be erected and filled with concrete in one week.

Construction joints between successive lifts of prepacked concrete presented a problem. The aim was an uneven joint with uniform concrete density throughout. The geometry of the crates and the large number of embedded items prevented the use of top forms. Vertical reinforcing bars were placed to maintain structural continuity of the concrete between successive crates. Heavy aggregates were then placed to within 19 in. of the top of each crate. Since surface flooding of grout was undesirable, the grout at a construction joint was kept about 8 in. below the top surface of the aggregate. As an aid in controlling this grout elevation, short sections of 2-in. pipe were placed in the top layer of prepacked aggregates so that they extended about 12 in. down into the aggregates.

Just before a crate was grouted, water was pumped into the bottom of the aggregate mass through several insert pipes. This provided a check on the watertightness of the form, promoted a uniform grout rise, and assured that all the voids in the aggregate would be filled with heavy grout. About 2 ft of water was carried above the grout surface to start with. When this water appeared at the top of the aggregate, it was removed with a pump. The presence of grout near the top aggregate surface was noted by observing the immediate rise of water in the 2-in. sump pipes. Occasionally grout did boil up through the layer of aggregates in localized areas, but procedures were developed to minimize this difficulty. Any grout or laitance which covered the aggregate surface was allowed to dry and then was removed before the aggregates were placed in successive lifts of the next crate.

The grout insert pipes were removed during the grouting operation. At the conclusion of grouting, the top aggregate surface was covered with water, which was removed just before the next higher crate was erected. Thermocouples placed in the concrete indicated that a maximum temperature rise of about 12 deg F occurred in around 30 hours in the front and rear crates, and 18 deg F at 50 hours in the side crates. During this period, the 2-in. sump pipes were turned occasionally and then removed, leaving a hole through the top layer of aggregates down to the hardened grout. Grout insert pipes were then placed in these holes for the next lift.

Grout data and methods

A heavy grout made with limonite sand was developed especially for this job. It had good pumping qualities and weighed about 147 lb per cu ft. Because the limonite sand used had a high content of natural fines, there was no separation of grout ingredients. A special admixture called Intrusion Aid, manufactured by the Concrete Chemicals Company of Cleveland, Ohio, was also used to impart expansive and colloidal properties to the grout. Equipment for mixing and pumping grout was set up about 200 ft from the shield and produced up to 6 cu yd of grout per hour. Each mixer could handle a batch of grout every 5 min. A batch consisted of four bags of Type II portland cement, 480 lb of limonite sand, 6.5 lb of Intrusion Aid, and about 210 lb of water.

In solidifying the top shield, two mixers and four pumps were used to pump grout into the prepacked aggregates while only half the plant was required for supplying grout to the side crates. During grouting operations, the grout inserts along the centerline of each side crate were pumped consecutively for 4 min each until grout appeared in the 2-in. sump pipes. Side inserts in these crates were then

Grout pipes extend to bottom of side forms of shield or to surface of previously placed grout. Location of pipes and rate of grout intrusion were arranged to penetrate all voids without flooding surface of aggregate. Here aggregate in side crate is being solidified. Layer of conventionally mixed heavy-aggregate concrete will be placed on top, after which shield will be completed by covering it with a steel sheet.

pumped until all sumps showed evidence of grout approaching the aggregate surface.

A slightly different procedure was used for grouting the top shield, which was divided into four quadrants. Inserts in each quadrant were pumped in a predetermined pattern designed to bring up the grout evenly through the aggregate mass without flooding the surface. After grout was within about 8 in. of the top, all sump pipes and grout inserts were removed. The upper layer of aggregate in the top shield was then penetrated with grout by forcing a special insert down into the aggregate with the aid of a pneumatic hammer. Excess surface grout was then removed and the top shield covered with 10 in. of magnetite-limonite premixed concrete. This concrete cap layer was placed conventionally and then covered with a steel membrane, thus completing the construction of the biological shield.

Quality of work evaluated

Three general conclusions have been drawn from this work:

1. The quality and uniformity of the heavy aggregates were very good. The steel, limonite, and magnetite aggregates, and the grout used on this job produced sound concrete having a compressive strength of over 5,000 psi at 60 days.
2. Workmanship and control during construction were adequate for obtaining concrete having the specified density and composition. Reasonable assurance was obtained that the coarse aggregates were prepacked to the required densities; that segregation and breakage of pieces of coarse aggregate were minimized; that all void spaces in the aggregate mass were filled with limonite grout; and that the concrete hardened in full contact with pipe, casings, and other embedded items.
3. The Intrusion-Prepakt method is suitable for constructing concrete shields made with heavy aggregates. Especially is this true when steel punchings are used as coarse aggregate or when high-density concrete is to be placed in restricted areas and around numerous embedded items.

The shields were constructed by Kaiser Engineers, a division of the Henry J. Kaiser Company, under contract with the Atomic Energy Commission. High-density concrete was placed under the supervision of Intrusion-Prepakt, Inc., a subcontractor of Kaiser Engineers. The General Electric Company was responsible for the design and technical direction of the reactor construction. The Hanford Atomic Products Operation is operated by the General Electric Company for the Atomic Energy Commission.

Report of Engineers Joint Council on Professional Standards and Employment Conditions

ARE EMPLOYMENT

Officers of EJC: Thomas H. Chilton, AIChE, President; Edgar J. Kates, ASME, Vice President; Esworthy P. Lange, AIME, Secretary; E. Lawrence Chandler, ASCE, Treasurer.

Unlike the members of most learned professions, engineers usually are employees rather than private practitioners. Surveys indicate that about eighty percent of professional engineers are in the employee classification, and this situation sometimes creates special problems which are not inherent in the other professions. One such problem is how specifically to create and maintain an employment atmosphere consistent with high professional standards.

Certain conditions of employment have had a profound influence on engineers and, among other factors, have caused a number of professional employee groups to turn to collective bargaining. There is a need, therefore, for the engineering profession to state clearly the employment conditions that engineers expect as professional men. Employers should align their policies with respect to the engagement of professional engineering personnel to meet these expectations. Mutual understanding between employers of engineers and the engineering profession is essential to the establishment of an environment which will encourage the individual engineer to achieve full professional stature.

A special committee of Engineers Joint Council was charged with the study of this employment problem. This committee's study treats but one of many problems confronting the profession. Engineers Joint Council expects to continue its study of the problems relating to the employed engineer.

The Board of Directors of Engineers Joint Council has adopted the following report with a view to analyzing the problems of current employment conditions as they relate to the individual engineer. Ten major topics were studied and covered in this report, as discussed under the heads which follow.

1. The present situation

The expansion of engineering from its beginning in military and civil engineering a century ago to a multiplicity of disciplines today has created a host of problems. Of major concern to the engineer is his relationship as a professional man with his employer. This relationship is influenced largely by employment conditions including salaries, training programs, security policies, levels of responsibility, job classifications, and identification with management.

Because the needs, responsibilities, and contributions of professional employees have not been recognized adequately in some instances, there has been a movement toward the unionization of engineering personnel. This has had an adverse effect on the professional concepts of many engineers, for a professional man must rely for recognition first on his own personal competence and integrity. In addition, confidential relationships which should exist between employers and professional engineers have been jeopardized.

The fact that there has been a trend toward collective bargaining by engineers, in spite of widespread reluctance to participate in such action, demonstrates the existence of unsatisfactory

CONDITIONS CONSISTENT WITH FULL PROFESSIONAL STATURE?

conditions. The engineering profession and management have a great stake in the solution of the problem, and the latter must accept its share of the responsibility for alleviating unfavorable employment conditions.

2. The causes of this condition

The reasons that have fostered collective bargaining among engineers have been studied and may be grouped as follows:

A. Professional treatment

a) A feeling among engineers that they were not identified with management, whether they were employees in industry, private engineering firms, or public service.
b) Inadequate channels of communication between top management and non-supervisory engineers.
c) Inadequate recognition of the engineer as a professional employee.
d) Assignment of engineers to subprofessional work.
e) Undue retention of engineers in specialized and narrowly compartmentalized assignments.
f) Lack of appropriate means for resolving individual problems.

B. Personal treatment

a) Inadequate recognition and treatment of the engineer as an individual.
b) Lack of broad position classifications and appropriate titles by which the engineer could measure his progress.
c) Inadequate or nonexistent plans for training and job rotation.
d) Inadequate understanding of promotional policies and belief that progress and promotions were not commensurate with ability and performance.
e) Feeling of insecurity of employment
f) The fact that management's human relations knowledge and skills have not kept pace with the expanded utilization of engineers.

C. Financial treatment

a) Engineering salaries not commensurate with fundamental contribution.
b) Too small a differential between the pay of engineers and members of the skilled trades.
c) Salaries of experienced engineers not sufficiently increased, in comparison with present starting salaries.
d) Wide variation in salaries paid to engineers doing comparable work in different organizations.
e) Dissatisfaction with merit review systems and inadequate understanding of salary administration.

Faced with these conditions, some engineers have resorted to unionization in the belief that corrective action could be effected only by pressures on management through collective bargaining. Even though they may have realized that professionalism requires freedom of action, these engineers appear to have been willing to submerge this principle in their attempt to get more pay and better working conditions through union activity.

3. Summary of historical background

The accelerated development of mass-production techniques in this century stimulated a rapid rise in labor union activities. Labor and management faced common problems of increasing complexity. In 1935 the United States Congress enacted the National Labor Relations Act, better known as the Wagner Act, which guaranteed to employees the right to organize and to bargain collectively and protected labor unions against specified unfair labor practices on the part of management. At that time there was little realization on the part of the professions of the potential impact of the Wagner Act on professional employees. However, the established labor unions soon took advantage of the situation and it was not long before many professional employees found themselves included, against their individual desires, in heterogeneous bargaining groups.

Legally, it was possible to form bargaining groups composed solely of professional employees. Practically, it was difficult to do so. Wherever a heterogeneous bargaining unit existed, it was next to impossible for professional employees to segregate themselves since the Wagner Act made no distinction between them and non-professional workers.

Some engineering societies, particularly the American Society of Civil Engineers, undertook to chart a course of action designed to assist professional employees against inclusion in heterogeneous groups. At first, the effort met with but minor success. Later, Engineers Joint Council determined to present its views to Congress with the hope that the Wagner Act might be amended to provide recognition of the status of professional employees and to enable them to act effectively on their own behalf. Pertinent clauses were included in the Labor Management Act enacted by the Congress in 1947—better known as the Taft-Hartley Act.

Of interest to the engineering profession, this law specifically provides under Section 9 (b):

"The Board shall decide in each case whether, in order to assure to employees the fullest freedom in exercising the rights guaranteed by this Act, the unit appropriate for the purposes of collective bargaining shall be the employer unit, craft unit, plant unit, or subdivision thereof; PROVIDED that the Board shall not (1) decide that any unit is appropriate for such purposes if such unit includes both professional employees and employees who are not professional employees unless a majority of such professional employees vote for inclusion in such unit. . . ."

The term *professional employee* as included in the Act is defined as:

"(a) any employee engaged in work (i) predominantly intellectual and varied in character

as opposed to routine mental, manual, mechanical, or physical work; (ii) involving the consistent exercise of discretion and judgment in its performance; (iii) of such a character that the output produced or the result accomplished cannot be standardized in relation to a given period of time; (iv) requiring knowledge of an advanced type in a field of science or learning customarily acquired by a prolonged course of specialized intellectual instruction and study in an institution of higher learning or a hospital, as distinguished from a general academic education or from an apprenticeship or from training in the performance of routine mental, manual or physical processes; or, (b) any employee who has (i) completed the courses of specialized intellectual instruction and study described in clause (iv) of paragraph (a), and (ii) is performing related work under the supervision of a professional person to qualify himself to become a professional employee as defined in paragraph (a)."

Under the Taft-Hartley Act a group of professional employees in any place of employment may decide by majority vote of their own numbers whether they want to form a unit of their own for collective bargaining purposes, to join with some other bargaining group, or to refrain from collective bargaining entirely.

It was hoped that the amended act would provide a satisfactory solution to the problem of inclusion of engineers in heterogeneous unions. Professional employees could disassociate themselves from heterogeneous groups. It was not expected that employees of professional status ever would desire anything like a nation-wide bargaining union. It was hoped that labor unions would respect the statutory rights of professional employees.

Those hopes today lack much of full realization.

A number of bargaining groups of professional employees have come into existence. Some appear to have functioned constructively; the same can hardly be said of others. Already there is a nation-wide union, self-designated as an engineering union, which aspires to power. Although some professional employees have been able to disassociate themselves from heterogeneous group, craft unions, particularly in the construction industry, are forcing more and more engineers into their ranks by bringing economic pressure to bear on employers, thus avoiding the election machinery of the Taft-Hartley Act. Clearly, many members of the engineering profession and employers of engineers are not doing enough to ensure enforcement of the letter and the spirit of the law.

The recent merging of the American Federation of Labor (AFL) and the Congress of Industrial Organizations (CIO) brings into being a large and powerful labor organization among whose objectives are increased efforts toward unionization of office employees and technical personnel. That effort will have direct impact on professional engineers.

To obtain reliable statistics regarding the current status and thinking of a cross section of the engineering profession, four constituent members of EJC, namely, ASCE, ASME, AIEE, and SNAME, polled 117,917 of their members on specific questions concerning collective bargaining. Of those polled, 66,938 or 57 percent, responded.

Returns showed that 48,082, or 72 percent, of the 66,938 respondents opposed collective bargaining for professional engineers, and that 44,168, or 66 percent, felt that collective bargaining is incompatible with professional status.

Further, the 66,938 responses showed that less than 4 percent were actually members of established collective bargaining groups; 27 percent reported as not being opposed to collective bargaining; 20 percent reported that they believed collective bargaining would be advantageous to them; and finally, less than 1 percent of the membership of three member societies (the fourth did not ask the question), would prefer to be represented by a craft labor union.

These results present a challenge to the engineering profession and to engineering management. The thinking of the remaining 43 percent of the 117,917 members polled, who did not respond to the questionnaire, is still unknown, but assuming that the sample was representative, there would then be 30,300 members who are not opposed to collective bargaining for professional engineers.

These results emphasize the situation confronting the profession in spite of the protective clauses in the Taft-Hartley Act.

4. Statement of problem and suggested solutions

A summary of the above might lead to two basic reasons for the present situation:

1. Engineers have not always realized and understood the professional characteristics of their roles.

2. Management has not always realized and accepted its obligations to engineers.

If these are the causes, the problem may then be stated as how to get the engineer to appreciate the professional characteristics of his position and how to get management to realize and accept its obligations to its engineers.

Immediately certain solutions present themselves, and these may be listed under five main headings:

1. Point out to the engineer and reemphasize to him that engineering is a profession and that he therefore has certain definite responsibilities.

2. Point out to management, through all feasible ways, that it has responsibilities to the engineering profession.

3. Point out to professional societies the part they should play in the advancement of their profession.

4. Point out to engineering educators their responsibilities for developing professional concepts in their students.

5. Point out to society the contribution of the engineer to its general welfare.

The purpose of the rest of this report will be to bring to the attention of all concerned their respective responsibilities. It is hoped that sufficient distribution and publicity will be given to it to stimulate a realization on the part of the public that engineering is a profession with high ideals and one that has made preeminent contributions to our modern civilization and high standard of living.

5. Engineering—a profession

Engineering is the art and science by which the properties of matter and energy are made useful to man in structures, machines, and products. Accomplishment of these ends requires not only scientific training, but also creative imagination, judgment, and an appreciation of the economics involved. The work of the engineer is predominantly intellectual and varied. The dictionary defines engineering as a mental activity rather than a manual skill. The engineer must exercise discretion and judgment, he must wish to serve, and his relationship with management must be one of confidence; in fact he is part of management. The engineer is charged with the protection of the public health and the public safety. The builder of a bridge, an airplane, a water supply, a dynamo, a kitchen range, an automobile, or a chemical plant must be concerned with its safe operation. Responsibility rests on his shoulders; if he does not accept that responsibility, he is not professional.

Professions require knowledge and skills on a high plane and all require that the practitioner work in a relation of confidence. In the ministry, medicine, and law this relationship is usually on an intimate personal basis, but in engineering it usually is more general and, indeed, involves obligation to the public at large as well as to the employer or client. The engineer's code of ethics requires that "he will have due regard for the safety of life and health of the public and employees who may be affected by the work for which he is responsible" and that "he will act in professional matters for each client or employer as a faithful agent or trustee."

Since clients and employers usually do not have the technical knowledge necessary to judge technical work, the engineer is bound to place their protection above his personal convenience or his immediate personal gain. A fundamental principle of professional responsibility is trusteeship. This is also a fundamental principle of management. To the employed engineer this means that the professional attitude involves a "management-oriented" point of view.

Engineering operations today are varied and extensive. Men at all levels of training and competence are required to carry out vast engineering enterprises. The work of the draftsman, the layout man, the toolmaker, the plant operator is indispensable, but does not require the imagination, the educational background, or the judgment of the engineer who conceives and executes the broader aspects of the projects.

The work of a truly professional engineer is so far from a routine, established pattern that only he can provide the initiative, the discretion, and judgment to achieve the successful accomplishment of his particular tasks. Because he alone knows with what comprehension, ability, and likelihood of success he approaches his assignment, the professional must accept individual responsibility or else advise his client or employer that other help is needed.

Professional attitude involves the following five basic concepts:

1. A social consciousness, a desire to contribute *to* rather than simply to benefit *from* civilization; a resolve to place the public welfare above other considerations.
2. The acquisition of special skills on a high intellectual plane, generally evaluated by means of self-imposed standards of excellence.
3. A sense of trusteeship—personal responsibility to protect the client's or employer's interest.
4. Individual initiative and acceptance of individual responsibility, both of the highest order.
5. A right to expect and to receive adequate financial recognition.

Prestige, however, is something that must be won. It cannot be bought or automatically accorded through affiliation with an organization. It is something that one can *command* but never *demand*. In the final analysis, an engineer achieves professional standing only to the extent that he accepts his responsibility to himself, to his client or employer, and to society.

Attainment of a degree in engineering from an instituiion of recognized standing implies that the graduate has mastered a certain curriculum and that he has the ability to understand, to assimilate, and to apply the knowledge that qualifies him to become a member of the engineering profession.

Although social consciousness is not necessarily a corollary to superior mental competence, most people who are endowed with such competence do have a sense of responsibility to the social order of which they are a part. They have learned to look on life as an opportunity to contribute to the civilization that fostered them and thus to better the lot of those who follow. To the engineer who feels that life provides opportunity for constructive contributions to society, collective bargaining with its attendant potentiality for creating conflicting obligations is not acceptable.

6. Responsibilities of the employee

"As an engineer, I will participate in none but honest enterprise. To him that has engaged my services, as employer or client, I will give the utmost of performance and fidelity."—Faith of the Engineer.

The engineering employee is bound by the same ethical and moral principles that apply to a member of any other learned profession. The responsibilities of an engineering employee are many. He is obliged to perform the professional assignments entrusted to him to the best of his knowledge and ability. He should give needed professional counsel in his special field and render loyal service. He should respect the economic problems of his employer. He should be thorough, expeditious, original, and accurate in the execution of his duties and assignments. He should have a rational attitude toward his work and fulfill each task with a minimum of supervision. At all times he should strive to improve the quality and increase the quantity of his output.

Education is important to the engineer and he should foster its continuance for those who are subordinate to him. He should strive to recognize and to utilize the diverse capacities of all fellow employees. He should strive for good planning and clear, concise reports. He should be friendly and maintain good appearance. He should develop the ability to be a good listener as well as the ability to express his thoughts effectively.

It is axiomatic that just as management has responsibility to employees, so do employees have responsibilities to management. The engineer employee should realize that he is not just another hired hand. He should know that to achieve full professional stature he must develop himself to rise above the technician or engineering assistant. He must have a genuine desire to expand his capacity, to extend his knowledge, and to improve his proficiency.

Any employee who is unwilling to assume responsibilities beyond those accompanying his present job has little right to be critical about lack of advancement. If he feels that he is not getting earned recognition, it may well be that critical self-appraisal is in order. One cannot just wish oneself up the ladder or depend on someone else to push or pull him along the way to success. The fact that a man has acquired a bachelor's degree in engineering does not, of itself, entitle him to any lasting professional recognition. It remains for each individual to prove by his own ability, integrity, and conscientious application to duty that he deserves recognition.

7. Responsibilities of management

Surveys show that more than 40 percent of those in management were trained as engineers. It seems illogical, therefore, that often there is inadequate communication between man-

RECOMMENDATIONS in EJC Report are that:

1. Management utilize the services of engineers more effectively and thereby afford them opportunity for advancement and economic improvement.

2. Management recognize its responsibility to make engineers feel that they are a part of management.

3. Management survey areas of communication, recognition, and salaries and, where found wanting, make corrections to conform with standards of professional practice.

4. The engineer take inventory of his services and his actions to make sure that he has a professional attitude toward his work.

5. Engineering societies establish and employ appropriate means to maintain high standards of ethical conduct for professional achievement.

6. Engineering societies encourage the professional development of their members and promote proper recognition of the profession.

7. Engineering educators emphasize the characteristics of the profession.

agement and engineers with consequent lack of understanding on the part of management as to the reasons for dissatisfaction among professional employees.

Management must recognize the inherent professional character of engineering work. It should be a policy of management to use its professional employees to the maximum of their capabilities. Except during the training period, the engineer should not be assigned to tasks which do not require his technical training, and he should be accorded individual and professional status commensurate with the quality of his contribution.

There must be opportunity for a continuation of education. It is important that professional employees be given opportunities to participate in the activities of scientific and technical societies. It is important that they receive credit for their contributions to the advancement of technical knowledge or to the profession as a whole.

There must be adequate communication between management and the professional employee. There should be organized orientation and training programs for new employees. Engineers need to understand the basic policies of their employers. They need to know their responsibilities and their opportunities for advancement. Adequate management-employee communications require a day-to-day relationship supplemented by periodic performance reviews, and other appropriate techniques.

Salaries must be established which will recognize the contribution of the professional employees as related to that of other groups. Salary differentials between various levels of technical experience have been substantially narrowed during recent years. Engineers who, after a period of satisfactory employment, find their salaries are only slightly higher that those of the recent graduate and possibly lower that those of a skilled craftsman, are not working in a favorable atmosphere.

Management must minimize the fear of job insecurity by adopting feasible means for stabilizing the employment of professional personnel and suitable termination policies. Since many engineers become managers, there is a need to insure that they will be employed and developed in an atmosphere that will fit them for their future responsibilities. Executive talents must be developed by experience and training in those phases which lead to managerial responsibilities.

8. Responsibilities of the societies

The engineering societies must take the lead in the advancement of the profession. Among the basic responsibilities of the engineering societies are the establishment of standards of ethical conduct, rigid requirements for admission to membership, accreditation of educational institutions which grant engineering degrees, and awards and prizes in recognition of worthy contributions to the advancement of the profession.

The national engineering societies have an additional responsibility to foster a healthy professional climate for employed engineers. Their governing boards and their individual members should unite in exerting their best efforts toward solving the problem. These responsibilities are so challenging and so vital to the current problem that they must be considered as obligations.

Current efforts of national committees to encourage the professional development of engineering society members, and to promote recognition by the public of the professional character of the engineer's work, should be expanded. An objective evaluation of the problem should be continued, followed by specific recommendations for the good of the profession. Engineering societies should adopt official statements for membership information with respect to collective bargaining to the extent permitted by their charters and constitutions. They should acquaint their memberships with those provisions of the Taft-Hartley Act which have a special significance for professional engineers. Constructive programs for encouraging professional consciousness on the part of engineers both before and after graduation should be sponsored. Therefore, the engineering societies and Engineers Joint Council should inform management as to the standards that will contribute to full professional achievement.

The engineering societies should provide guidance and assistance to educational institutions confronted with any problem which is detrimental to the achievement of full professional training of students.

9. Responsibilities of education

Engineering colleges have a primary responsibility for developing professional concepts in engineering students. Professional concepts should be developed by applying them to the solution of engineering problems in the technical courses, in lectures, in association with students, and by good example.

Opportunities for engineering educators to become better acquainted with the total environment in which engineers work should be expanded through temporary employment in non-academic fields and the utilization of employers with "professional vision" in classrooms and student seminars. Such activities enable students to appraise their status more realistically upon graduation.

10. Conclusions and recommendations

Both employer and employee have obligations and responsibilities. Each of course has the responsibility to advance his own welfare. Beyond that, and yet a part of it, each has a responsibility to the other and to society. Grave responsibilities for inculcating and developing professional consciousness in young members of the profession rest upon the educational institutions and professional societies. Various phases of such responsibilities have been stressed in the several sections of this report.

Without a sound technical foundation, no man can become a competent engineer. But more than technical competence is demanded of any one who expects to be recognized as a professional person. One must understand and observe appropriate ethical standards and it is important to cultivate proper understanding of such standards.

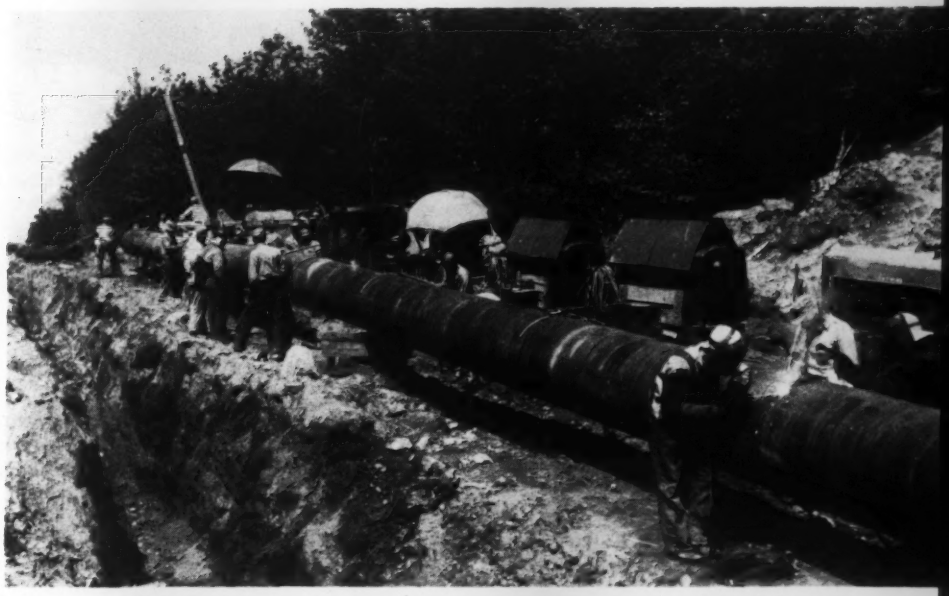
The ECPD program, "The First Five Years of Professional Development," is an excellent step in the right direction. Here is opportunity for the engineering societies, the colleges, industrial management, and civic institutions to work together to aid young graduates in continuing their education and in adjusting themselves to conditions to be met in the practice of their profession.

The present report has been prepared with full realization that the subject refers chiefly to one phase of professional life. An attempt has been made to identify factors that have significant bearing on the specific problem under consideration. Concerted efforts by all concerned with the advancement of the profession are required if a satisfactory solution is to be found. It is believed that if the recommendations submitted are followed by those to whom they are directed, substantial improvement in the standing of the profession will result. There is no simple solution, but the following recommendations are presented. [These recommendations are given in the accompanying box.]

(Copies of the EJC Report on Professional Standards and Employment Conditions, as presented by the committee, are available from Engineers Joint Council, 33 West 39th Street, New York 18, N.Y.)

PIPELINES . . .
a field for civil engineers

STEPHEN D. BECHTEL, JR., A.M. ASCE, Senior Vice President, Bechtel Corporation, San Francisco



One of most important items of management is field inspection to assure conformance with specifications. Welding, here seen under way on Lakehead Pipeline Extension, west of Ashland, Wis., is one of most important and closely supervised operations. It immediately follows bending.

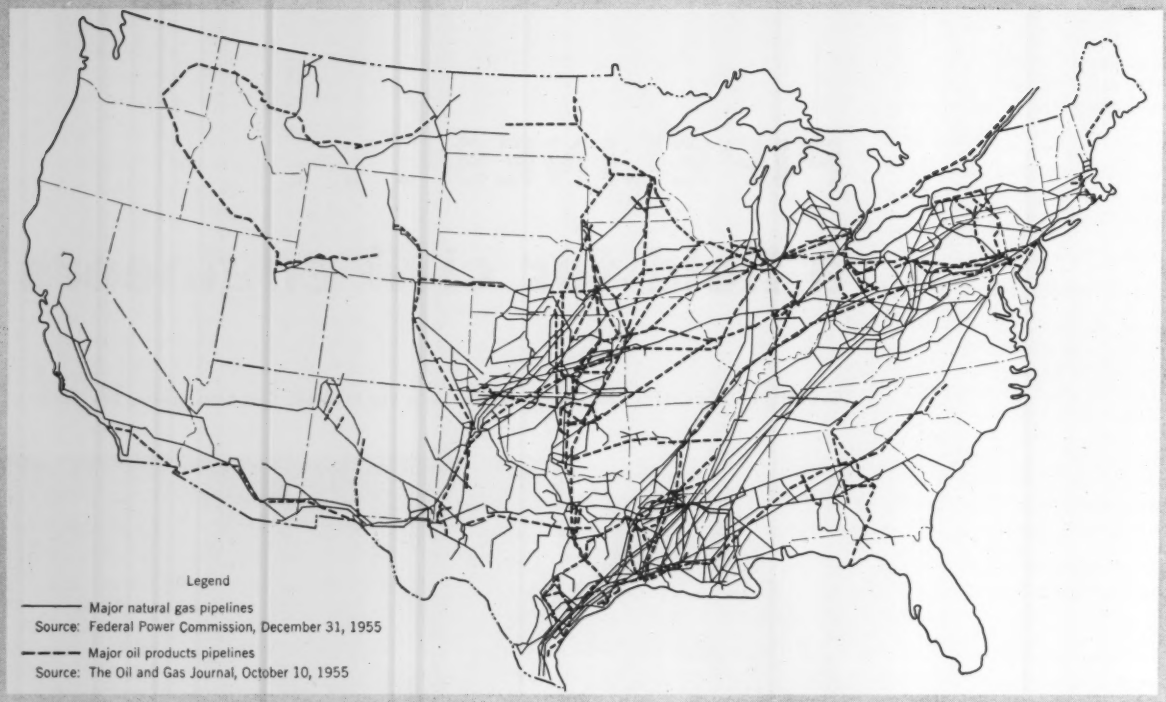
Pipelines have been an early invention in every civilization. They have been built of wood, stone, tile, concrete, cloth, rubber, all kinds of metal, and now plastic. They have been used to convey all types of liquids and gases, and even minerals, ore, and coal in suspension or slurry. It is probably safe to say that in every case they have improved the standard of living of the users, and in no previous era have pipelines been as useful or as big a factor in the economic life of a people as they are today in the United States. (Fig. 1).

In the United States in 1955, the oil and gas industry alone built some 15,000 miles of new pipelines, and they plan to build another 17,000 miles in 1956. The construction of these new pipeline facilities amounts to a current rate of expenditure of about one billion dollars a year. These figures do not include Canadian or other foreign projects, in most of which American engineers and contractors play a prominent part, nor do they include water or sewer pipelines.

Many factors have contributed to this boom in pipelining. Probably the strongest is the demand for a better, more convenient, and cheaper fuel supply. The manufacturers have contributed to their own boom by making a stronger and more uniform pipe, and the contractors have contributed by better and quicker methods of laying.

The term "pipelining" is most commonly applied to cross-country, welded steel pipelines transporting natural gas, crude oil, or petroleum products. This article is limited to such pipelines, although the general principles, and many of the problems encountered, are common to other types of construction.

One feature which distinguishes most civil engineering work from that in other fields of engineering is the predominant influence of the physical features of terrain on design and construction. This criterion places pipelining in the civil engineering field without question. The place of the civil engineer in this industry is probably illustrated by a description of the se-


Legend
Major natural gas pipelines
Source: Federal Power Commission, December 31, 1955
Major oil products pipelines
Source: The Oil and Gas Journal, October 10, 1955

quence of operations from conception to completion of a new pipeline project.

Project operations can be divided into two phases—first, management, encompassing economic investigation, route location and mapping, right-of-way acquisition, design, material procurement, and inspection of construction; and second, physical construction of the pipeline.

Economic feasibility of first importance

The first step in any pipeline project should be an investigation to determine whether it is economically sound. This requires the highest degree of engineering skill, experience, and judgment. The supply and market data must be gathered and analyzed to determine the average quantities to be transported; and often the daily, monthly, and yearly variation in these quantities must be determined. Usually several alternate routes or systems must be investigated and evaluated, using topographic maps, highway maps, aerial reconnaissance, and field inspection.

Preliminary designs for various line sizes, sizes and types of stations, station spacings, and system hydraulics must be made for the quantities to be transported, making adequate allowance for future expansion. Accurate estimates of capital and operating costs must be prepared from these preliminary designs and route investigations.

The influence of local weather conditions, governmental regulations, probable upward wage trends for labor, schedules for delivery of materials and for construction—all must be considered. The methods of financing the project must be selected to determine amortization and interest costs. Finally, a financial analysis of the project over several years of operation must be made to determine its economic soundness.

When the decision to proceed with the project has been made, a schedule of engineering, surveying, procurement, and construction must be drawn up so that all operations are properly timed to avoid delays.

Air and ground surveys needed

Available maps and aerial reconnaissance notes are reexamined in detail to determine a preliminary route and location, and survey crews are sent into the field. Aerial photography has become a most useful tool in pipeline location, and usually the first step is to lay out a route on aerial mosaics. The locating engineer and preliminary survey crews then usually examine the proposed route in the field on the ground. Major river crossings or other natural obstacles may fix certain points on the line.

The skill of the locator is very important at this stage. Every deviation from a straight line between control points adds to the length of the line and thus usually to the capital and operating costs. The locator should be cognizant of construction and maintenance practices and costs, so that each deviation is economically justified. It is also desirable that he be familiar with design requirements. For example, the crossing of a pass at a lower elevation, even though the terrain is more difficult and the route longer, may be most economical for a liquid line where the static head may govern pumping requirements. On the other hand, if a gas line were to be constructed through the same area, the elevation might be a less important factor and the route might be chosen to take advantage either of the more favorable terrain or of the shortest route.

As the location and survey work progresses, the line is mapped and property ownerships determined. Detailed location and profiles of river crossings, and railroad and highway crossings must be prepared, and approvals obtained from the governing bodies for such crossings. Maps of the entire

Following welding comes cleaning and coating with coal tar or asphalt, then wrapping with one or more layers. In photo at left, "dope" gang comes over the hill near Stamford, Conn., cleaning and coating pipeline of Northeastern Gas and Transmission Co. Photo below shows triple-wrap operation near Newberry, Calif., on Pacific Gas and Electric's 34-in. gas line.

←

Fig. 1. Major pipelines for natural gas and oil products form vast network radiating from oil and gas fields to feed metropolitan areas. New pipeline facilities are being constructed at current rate of a billion dollars a year.

line must be prepared in the form required by governmental authorities, and the line must be staked for construction.

Concurrently with the line location and surveying, the land agents contact all property owners along the proposed route to obtain permission to survey and to get options for the purchase of right-of-way easements. Closest cooperation and exchange of information between the land agents and the field engineers are required. Inability to obtain property at a reasonable value may require rerouting of the line, if the right of condemnation is not obtained or used. Also, any construction restrictions such as extra depth of trench, segregation of top soil, or restricted right-of-way, should be noted on the construction drawings so that such special requirements can be included in the contract and taken account of by the contractor in his construction price.

Further, at the conclusion of construction, the maps should be corrected and completed to show the line location and length, as actually built, the location of all property lines, physical features and all facilities, including main-line valves and cased crossings. In the case of liquid lines, these as-built drawings usually include a profile of the pipeline as an aid in operation and maintenance.

Designed with care

Meanwhile the design engineers have been busily engaged in perfecting the details of the original pipeline design. This must be correlated with the actual field conditions as regards line length, elevations, and valve and station locations. Often, many relocations may be found desirable to reduce construction costs, and all these must be referred to the designers to determine the effect on the hydraulics of the system and the horsepower requirements.

Flow formulas used for natural gas and oil pipelines may look unfamiliar to a civil engineer who has been accustomed to the hydraulics of water and air lines, in that they contain correction factors for variations in gravity and viscosity. All are based, however, on the fundamental flow equations and the laws of hydraulics; thus the experienced civil engineer handles this work with ease.

Special structures, such as suspension bridge crossings and restrained pipelines, are sometimes encountered and are usually treated as individual design problems. Appurtenances such as main-line valve installations, scraper traps, drips, and cased crossings are usually standardized. Design and research for pipe coatings, cathodic protection, and other forms of corrosion control are a specialized field claiming the attention of many engineers.

Design of compressor or pump stations requires the services of specialists in all fields of engineering. Often such stations are self-contained, utilizing as fuel the gas, crude oil, or other products being transported. The main compressor or pumping units may range from a few hundred to several thousand horsepower each, and quite often auxiliary units must be provided to generate electricity and to provide heat.

The site must be graded and fenced, roads constructed, water supply developed, sewage disposal facilities provided. Sometimes housing for operating personnel is required. There must be suitable foundations for the main units and their auxiliaries, such as generators, coolers, lubricating-oil pumps and purifiers, and cooling-water pumps. Large buildings are usually required to shelter the equipment, repair facilities, motor vehicles, and offices. A considerable amount of piping and manifolding is required not only for the gas or oil being pumped, but also for water, fuel, and air. Modern stations have elaborate electrical systems controlling valves, sequence of operations,

and alarm systems. Although the stations are adjuncts to the main pipeline, they are complete industrial plants in themselves.

Huge tonnages delivered

Procurement of materials, mill or plant inspection, shipping, and expediting are major problems on a long cross-country pipeline. For example, a typical thousand-mile, 30-in. pipeline may require 320,000 tons of pipe, 34,000 tons of coating materials, 300 tons of casing pipe, and 300 tons of valves and accessories—all delivered to eight or ten construction spreads moving at the rate of a mile a day. In addition, there may be 8,000 tons of machinery, piping, electrical, building and miscellaneous materials to be delivered to each of eight or ten station sites spread out over a thousand miles of line. To procure and ship this total of over 400,000 tons of material to the proper places, in the required amounts, and to meet a construction schedule of perhaps six to eight months, present problems in logistics which have few equals in the construction industry.

Complete specifications for the construction of the pipeline and stations must be prepared, and proposals taken for the building of these facilities. Sometimes contracts for large pipeline projects are let to several contractors to permit completion of the line in a single construction season. The engineer must divide the line into sections which vary in length with the relative difficulty of construction, so that all contracts will be completed within the required time. Separate contracts are ordinarily let for the stations and for major river crossings, since the pipeline spreads are equipped and manned to proceed at a rapid rate on main-line construction. Any special conditions which would retard progress can usually be handled more economically as separate jobs.

One of the most important items of the management phase is field inspection of construction to assure conformity with the specifications. Welding is of course one of the most important and closely supervised operations. Application of the coating material is another operation that should be closely supervised.

Physical construction of the pipeline is performed by craftsmen skilled in the various trades and operations and is not usually considered as an engineering function. However, pipeline construction, like many other types of construction, requires careful planning and scheduling of operations, and competent supervision. Training of the engineer in analytical thinking, ingenuity in overcoming obstacles, and willingness to accept new ideas and methods may be advantageously applied to the field of pipeline construction. More and more engineers are now found in supervisory and administrative positions in the pipeline construction industry.

Construction steps

The various steps in the actual construction of a typical, cross-country, all-welded steel pipeline proceed in the following sequence.

First comes the clearing and grading of the right-of-way to permit the passage of equipment for the construction of the line. Brush or timber must be removed and burned or otherwise disposed of. Swampy ground may require the construction of a corduroy road. Small streams may have to be bridged. Temporary fences and gates must be constructed across the right-of-way to prevent straying of stock.

After the right-of-way is graded, pipe and other materials must be unloaded at railroad sidings and strung along the route. Varying diameters and wall thicknesses of pipe must be located where called for by the design. During or following the "stringing," depending on the circumstances, the ditch must be excavated to receive the pipe. Wherever possible this is done with a ditching machine. The modern wheel-type ditcher is an efficient piece of dirt-moving equipment. A typical ditch for a 30-in. line, for example, will require the excavation of about $^{3}/_{4}$ cu yd per lineal foot of trench, and under favorable conditions a single ditcher may excavate $1^{1}/_{2}$ miles of ditch, or 5,500 cu yd, in a 10-hour shift. Where rock is encountered, drilling and blasting of course are required, and the excavation is made with backhoes. Wet or swampy ground is usually excavated with backhoes, draglines, or clamshells.

Preceding the actual welding of the line, the bending engineer carefully measures the bends in the ditch and in the pipe. He supervises the preparation of the bends, either vertical or horizontal, to permit the pipeline to conform to the alignment and profile of the bottom of the ditch. The bending machine is a large frame with guide shoes shaped to fit one half of the circumference of the pipe. A joint of pipe is placed in the machine and bent around the guide shoes either by cable or hydraulic power to produce a smooth cold bend of the desired radius. The required central angle is produced by making several incremental bends.

Following the bending crew come the line-up and welding crews. A side-boom tractor picks up a length or joint of pipe and moves it into alignment with the previously welded string of pipe. A line-up clamp is used to hold the pipe ends in alignment with the proper spacing, and one or more stringer-bead welders apply the first pass. As soon as the stringer bead is completed, the clamp is removed and the next

Lowering-in operation is carried out by side-boom tractor on Trans Mountain Oil Pipe Line near Blue River, British Columbia, Canada. Another view of this pipeline appears on the cover.

joint moved into position. The "production" welders follow the "line-up," completing the welds by the addition of the number of beads required by the pipe-wall thickness. During the line-up and welding process, the pipeline is supported on skids or cross timbers, either over or beside the ditch at a height necessary to permit proper welding.

Coating and wrapping the pipe

The next step is usually the coating of the pipeline with coal tar or asphalt and one or more wraps of glass fiber and/or felt or kraft paper. This coating is designed to provide an electrically resistant wrap of sufficient mechanical strength to resist soil stresses caused by the expansion and contraction of the buried line. When cathodic protection is applied to the pipeline, the coating serves to reduce the required current, since current will enter the pipe only at breaks in the coating.

The first step in the coating operation is performed by the cleaning-and-priming machine, which travels along the pipeline as it is supported or cradled by one or more side-boom tractors. This machine consists of a frame, self-propelled by a gasoline engine driving small wheels which rest on the pipe. Within this frame is a circular revolving head carrying spring-loaded cutters and brushes; these remove dirt, scale, and accumulated rust. Revolving arms, carrying a strip of carpet, smooth out the primer, which is applied at the rear of the machine.

The coating and wrapping machine is somewhat similar but has flood nozzles for applying the coal-tar or asphalt coating, and large revolving arms carrying spools of the wrapper, which is wound on the pipe in a spiral as the machine moves forward. Coating material at the proper temperature is supplied from a heated kettle, which is towed alongside the coating machine and connected to it by a flexible metal hose.

The coated and wrapped line is then lowered into the ditch, care being taken not to damage the coating. All clods, stones, and other material that might puncture the coating have previously been removed. In rocky areas a padding of sand or dirt 4 to 6 in. in depth is spread in the bottom of the ditch and around the pipe to protect it and its coating from stone bruises during final backfilling.

Preceding completion of the pipeline, a small crew goes ahead installing casing, where required, under railroads and paved highways. The casing is a larger-diameter pipe which is installed by boring or tunneling, and allows the main pipeline to be threaded under such crossings without disturbing traffic on the highway or railroad. It also permits removal of the line pipe itself at a later date should repairs be necessary. In the event of leakage in that part of the pipeline under such crossings, the gas or liquid is confined by the casing pipe, preventing erosion of the crossing.

Since the main pipeline crew must move with all possible speed, strings of pipe under crossings, points which have been left open for running of scrapers or testing, main-line valves and other appurtenances, and any other discontinuities in the finished line, are welded together and placed in the ditch by a small crew known as the "tie-in" gang.

While every effort is made during construction to keep the pipeline free from dirt and other extraneous material, it is the usual practice to run cleaning scrapers or "pigs" through the line to remove any such material. These may be propelled by air, gas, or liquid. After the line has been cleaned, the final test is made. Depending on the circumstances, this test may be made with water, with the liquid to be transported, or with air or gas.

Meanwhile, final backfilling and cleaning up are proceeding. Permanent fences are installed, location and aerial patrol markers placed, and the right-of-way restored as nearly as practicable to its original condition. Frequently, on completion of the pipeline and stations, the design and field engineers will give aid in putting the line in operation, and in familiarizing the operators with the equipment.

Our hypothetical 30-in. pipeline may be constructed at the rate of a mile a day, involving a total installed cost of $100,000 to $150,000 per mile. To equal this rate of expenditure a million-dollar office building would have to be built in from seven to ten days. Certainly pipelining is a field of design and construction worthy of the best effort, skill and ingenuity of the civil engineer.

When the pipeline is completed, operation and maintenance commence. The product to be transported must be gathered from various sources, and, after shipment, must be redistributed to the owner or customer. Often storage is necessary. Constant vigilance is required to prevent corrosion or other damage to the line or breakdown of the pumping machinery. The man who should be best qualified to supervise such work is the engineer who designed or built it. Thus the pipeline engineer who tires of the constant change inherent in new construction can usually find congenial, settled employment in the operating organization.

(The paper by Mr. Bechtel, on which this article is based, was originally presented at the ASCE Dallas Convention, before one of the three sessions of the Construction Division's Pipeline Committee, presided over by Eldon V. Hunt, Chairman of the Executive Committee of the Pipeline Committee.)

Just before completion of line, small crew goes ahead installing casing under railroads and paved highways. Here deadman at right angles to casing provides anchor for boring machine to pull against in preparing crossing under highway near Iron Mountain, Mich., for Lakehead Pipeline Extension.

Culvert and 30-ft fill solve bridge replacement problem

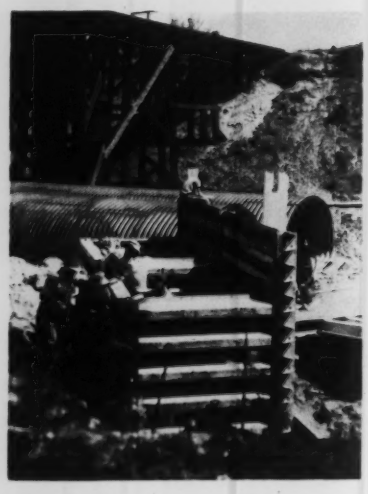
A. S. KREFTING, Assistant Chief Engineer, Soo Line Railroad, Middletown, Ohio

When the Soo Line Railroad was constructed in eastern Wisconsin in 1884, the track crossed a shallow ravine over a pipe culvert at Milepost 372.58 near Norton, Wis. The natural ground was a clean, fine sand which, when wet, became fluid and consequently suffered severe erosion. Eventually the ravine was eroded to a depth of 30 ft and the track crossed on a timber trestle 152 ft long with a 50-ft steel span in the center.

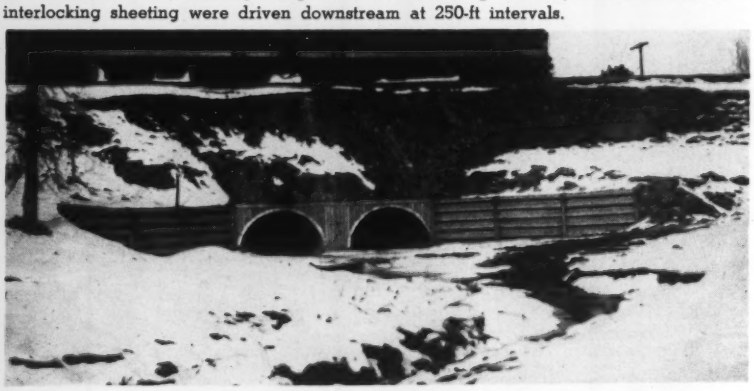
When the timber approaches and timber bents supporting the steel span were up for renewal, it was estimated that a steel bridge would cost $45,000 and a Multi-Plate pipe structure $37,000. The amount of drainage passing down the ravine was not great, but it was doubtful whether a bridge could be built that would withstand the further erosion to be expected. Because of this erosion problem, it was decided to install twin pipe arches, of No. 1 gage and 10-ft 11-in. span, with a rise of 7 ft 1 in. These twin culverts have headwalls of interlocking sheeting and bin-type wing walls also of interlocking sheeting. The structure was protected from undermining by interlocking sheeting 10 ft long, driven at the ends of the pipe and wings.

While the foundation was being graded and the culvert structure erected, the stream was diverted to the edge of the ravine. Lowering the diverted stream several feet and providing a sump upstream of the structure dried up the foundation sufficiently to provide suitable bearing for the pipe-arch. The foundation was fine graded with approximately a 5-in. camber in the flow line to compensate for the anticipated subsidence under the 30-ft fill to be placed over the culvert.

The Multi-Plate sections were delivered to the bridge by rail push cars and lowered to the site with a hand derrick. For erection, an A-frame on the front of a pick-up truck was used. The plates were assembled by bolts, which were tightened with air wrenches



Sections of Multi-Plate were delivered by rail and lowered to site from old bridge (upper left). Bin-type wing walls (foreground, lower left) were erected without batter, front wall being carried two stringers higher than others. Finished structure (below) is covered with 30 ft of selected fill, carefully compacted. For further protection, four ditch checks of interlocking sheeting were driven downstream at 250-ft intervals.



to the proper torque. The structure was coated on the outside with fibrated asphalt for additional durability.

Cutoff sheeting was driven by jetting part way down and finishing with an air hammer. The bin-type wing walls were erected vertically without the usual batter, and the front stringers were carried two stringers higher than the rest of the bins. Four interlocking-sheeting ditch checks were placed at about 250-ft intervals downstream from the structure to maintain the present grade of the valley floor and eliminate the possibility of undermining the culvert structure.

Backfill around and over the arches consisted of a mixture of sandy loam and gravel hauled in from a railroad borrow pit. The backfill was consolidated with gas-powered vibratory tampers to sufficient density to provide side support for the flexible metal structures.

Additional material to complete the fill was brought in on air-dump cars and placed and compacted by a D-6 bulldozer. A noteworthy feature of this job was the exceptional care taken to backfill around and over the pipe arches to a height of cover beyond the recommendations for average installations.

The steel span was removed and track laid on the fill in one day, October 27, 1954. Field measurements taken the next day showed that the pipe-arch was structurally sound with deflection well within safe limits. The work of installing the culverts was started in July 1954, and the whole project, including fill, was completed in December 1954. Since its completion, the culvert has stood up very well although it has not been subjected to floods of any consequence.

The work was done by the Construction Department of Armco Drainage & Metal Products, Inc., under the general direction of L. V. Johnson, Chief Engineer, and the supervision of the writer.

A short-cut to plotting parabolas

C. F. ENDE, M. ASCE

Project Manager, Ebasco Services, Inc., New York, N.Y.

While working on the design of an electrical transmission line in 1948, I discovered a method of plotting a parabola which I believe will be useful to anyone who has to do this type of work. The transmission line I was working on had many ruling spans and therefore many sag curves to be calculated and converted into templates.

The steps in this method are:

1. Calculate the sag for the maximum desired span and the tension loading and temperature desired.
2. Plot the semispan and the sag to any desired scale (Fig. 1). When this method is employed for transmission-line templates, the scales must be those used in the plan and profile of the line. In Fig. 1, the triangle *HFO* is given since the coordinate *a* represents the semispan and the coordinate *c* the maximum sag of the span.
3. From any point *G* on *FH*, draw *GO*. Then draw a line *GE* parallel to *OF* intersecting *OH* at *E*. From *E* drop a perpendicular to *OF* which intersects *OG* at *P*; *P* is a point on the parabola for which the maximum span sag was calculated. This parabola has its vertex at *O* and passes through *H*. Then take other points on *HF* above and below *G* and construct other rectangles like *EGFD* from which other points similar to *P* can be found. Usually eight or ten points are sufficient to enable one to draw a smooth curve that will be accurate enough for most uses.

The proof that the points fall on the parabola is as follows:

The general equation of a parabola with its vertex at the origin, may be written,

$$y = Ka^2 \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Point *H* is on this parabola, hence, substituting the coordinates of *H* in Eq. 1 we have

$$c = Ka^2 \quad . \quad . \quad . \quad . \quad . \quad (2)$$

$$K = c/a^2 \quad . \quad . \quad . \quad . \quad . \quad (3)$$

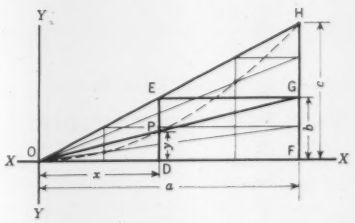


FIG. 1. Semispan *a*, and sag *c*, are plotted to any desired scale.

Thus for our parabola, we may write

$$y = \frac{c}{a^2} x^2 \quad . \quad . \quad . \quad . \quad . \quad (4)$$

From the similar triangles *OPD* and *OFG*,

$$\frac{x}{a} = \frac{y}{b} \text{ or } \frac{OD}{PD} = \frac{OF}{FG} \quad . \quad . \quad . \quad (5)$$

Whence

$$y = \frac{b}{a} x \quad . \quad . \quad . \quad (6)$$

Equating the right-hand members of Eqs. 4 and 6,

$$\frac{b}{a} x = \frac{c}{a^2} x^2 \quad . \quad . \quad . \quad . \quad . \quad (7)$$

$$\frac{b}{c} = \frac{x}{a} \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

But from the similar triangles *ODE* and *OFH*,

$$\frac{b}{c} = \frac{x}{a} \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

which is the same as Eq. 8.

Therefore point *P* lies on the parabola whose vertex is at the origin and which passes through point *H*.

For this mathematical proof that the points fall on the parabola, I am indebted to Prof. Don Ryan, Head of the Mathematics Department at Gonzaga University, Spokane, Wash.

THE READERS WRITE

Angle of pipe bend found by spherical trigonometry

TO THE EDITOR: The article on finding the angle of a fabricated pipe bend, by Lawrence P. Johnson, Jr., in the April issue (p. 73), deals with a problem that can most readily be solved by spherical trigonometry. While usually thought of as a triangle formed by arcs of great circles on the surface of a sphere, a spherical triangle may also be considered as three intersecting planes, or as three lines not in the same plane, intersecting at a single point.

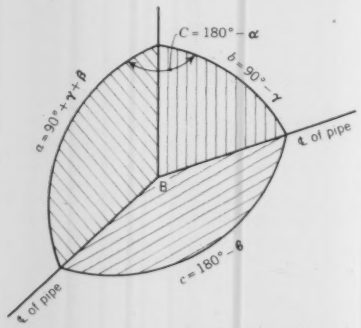


FIG. 1. Vertical point *B* (center of sphere), and centerlines of two arms of pipe intersect surface of sphere in three points, forming corners of a spherical triangle.

In Fig. 1 of Mr. Johnson's article, let the point called B' and B'' be the center of a sphere, and draw a vertical through it. This vertical and the centerlines of the two arms of the pipe will intersect the surface of the sphere in three points, forming the corners of a spherical triangle, as shown in the accompanying sketch (Fig. 1). The three known quantities are the angle C and the sides a and b, the values of which are given in the sketch. By spherical trigonometry, the unknown side c is given by the equation:

$$\cos c = \cos a \cos b + \sin a \sin b \cos C$$

$$\text{or } \cos (180 - \theta) = \cos (90 + \gamma + \beta) \times \cos (90 - \gamma) + \sin (90 + \gamma + \beta) \times \sin (90 - \gamma) \cos (180 - \alpha).$$

This reduces to

$$\cos \theta = \sin (\gamma + \beta) \sin \gamma + \cos (\gamma + \beta) \cos \gamma \cos \alpha$$

which is the same as Mr. Johnson's Eq. 4.

HENRY W. TROELSCH, M. ASCE
Bridgewater, Conn.

Expresses appreciation of technological progress

TO THE EDITOR: A friend has called my attention to an unwise choice of words in my part of the Panel on Professionalism, as printed in the March issue (pp. 41 and 42). The sentence in question, as there recorded, reads: "The medical practitioner is the one professional man who must continue to study as long as he lives or practices. . . ."

In the actual symposium discussion, I stated, "The medical practitioner is one professional man, possibly above all others, who must continue to study as long as he lives or practices. . . ." And I would have been wiser if I had stated it even more simply, "The medical practitioner, along with other professional men, must continue to study as long as he lives or practices. . . ."

I have deep appreciation and respect for the countless things in life that I enjoy, which are very definitely the results of the continuing and expanding efforts of professional men in all fields of endeavor, particularly in technology.

I appreciate having my attention called to this unfortunate phrasing and am happy to have the correction recorded.

MILFORD O. ROUSE, M.D.
Dallas, Tex.

Three longest tunnels in New York water supply

TO THE EDITOR: Ray E. Peterson, in the April issue (p. 96), has presented an interesting and valuable compilation of the world's longest tunnels.

There is one error in the list, however. The West Delaware Tunnel, shown as 20 miles long and in fifth place, extends from Cannonsville, N.Y., to the existing Rondout Reservoir, and will be 44 miles long.

The three longest tunnels on the list, then, all contribute to the water supply of the City of New York.

VICTOR FEIGELMAN, J.M. ASCE
Civil Engineer
Board of Water Supply
New York, N.Y.

Employer needs to know salary expectations

TO THE EDITOR: Commenting on Professor Brinker's letter in the March issue (p. 60), with regard to bidding for the services of an engineering employee, I think he has overlooked one important phase of the situation.

Our firm will not bid for engineering services, nor will we ask for bids from engineers for their services. However, I think it is wholly reasonable to ask an applicant what he thinks his services are worth before putting him to the expense of coming to our office for an interview, or committing ourselves to expending the time and effort necessary to check over his qualifications.

We have encountered several cases in which an inexperienced applicant had apparently formed an opinion of the value of his services either from working for an aircraft factory or from an interview with the personnel officer of a firm working for the Government on a cost-plus basis.

It is only fair to such an applicant to ask him what he expects in the way of salary, because a firm like ours, which operates on the basis of the curves and percentages of the ASCE, cannot in any way compete with the salaries paid by firms working on cost-plus for the Government.

I do not think that Professor Brinker should consider such requests for the applicant's idea of his desired salary range in the light of bidding for his services. Certainly we would never take an applicant on the basis of his price, but his price would have to be in line with what is compatible with the percentage fees published by the ASCE.

ROBERT C. WHEELER, M. ASCE
Barker & Wheeler
Engineers
Albany, N.Y.

SOCIETY NEWS

Kansas City Conference Appraises New Member Services of Technical Divisions

With an ever-increasing number of members participating in Technical Division work, significant new activities have resulted. This conclusion was reached during a two-day Technical Procedure Conference held in Kansas City, Mo., on April 6 and 7. The 60 Division and Society officers present gave attention, particularly, to details of organization and administration which encourage and facilitate such new activities. Noted especially were better media for communication of information, through sessions conducted by the Divisions and publications issued, and other efforts that bring the services of the Technical Divisions to the doorstep of the practicing engineer. In keynote remarks, ASCE President Enoch R. Needles defined the expansion of the services of the Technical Divisions as a professional obligation of the membership, and commended the 700 individual members now actively involved in some part of the operation.

The conference was attended by the President, Vice-Presidents and Directors concerned with the Technical Department and by the officers of the Divisions. An innovation made possible by Board action was the attendance of new Board Contact Members for the several Divisions. Presiding at the conference, as chairman of the Committee on Division Activities, was ASCE Vice-President Louis R. Howson.

Better Management of Committees Recorded

Much of the expanded activity of the Technical Divisions has been made possible through better management of committees, reported Ernest C. Hartmann, chairman of the Structural Division. Mr. Hartmann, who was one of 21 "discussion leaders" for the conference, described the machinery essential to operation of the 25 Structural Division committees. The constructive output of Division Committees, reported Mr. Hartmann, increases as a result of increased facility of operation and more frequent contact with committees by the officers of the Division. It was emphasized that all the Division operations require interested and willing manpower.

For most effective operation of Division committees, concluded Arthur D. Caster, secretary of the Sanitary Engineering Division, careful advance planning is essential. Mr. Caster indicated the steps leading to the planning of a committee meeting which will meet the convenience of members and, at the same time, turn out specific accomplishments. Again interested and willing manpower was cited as a need. To fill this need, Emmett H. Karrer, chairman of the Highway Division, outlined the facility offered by a Committee on Cooperation with the Local Sections, in locating able manpower at Local Section level.

More Inter-Society Cooperation Urged

Many of the Technical Divisions have found it helpful to cooperate with other technical groups. Such an operation was reported by Roy J. Morton, chairman of the Sanitary Engineering Division. In particular, he described the inter-society effort which led to the formation of the new Sanitary Engineering Inter-Society Board. While this operation has specific value for sanitary engineers only, some of the organization patterns, said Mr. Morton, would be applicable to any field of technique. Such cooperation has been manifest in the planning of programs also.

To accomplish such planning, the Divisions operate committees on Session Programs. New methods found valuable by the Soil Mechanics and Foundations Division were described by Stanley D. Wilson, chairman of that Division. Chairman Howson reported a study made on scheduling of sessions at conventions and conferences. His report indicated clearly that a Division must conduct a valuable program of several sessions to attract interest and attention. Key to such planning, as reported by Joseph B. Tiffany, chairman of the Hydraulics Division, is the facility within a Division for selection of speakers and subjects that will draw the interest of the profession. One scheme for appraising the value of such papers was described by R. Robinson Rowe, a member of the Committee on Division Activities.

A new but proved facility for outlet of technical information at Conventions was described by Herbert E. Prater, secretary of the Irrigation and Drainage Division, who reported on the conferences sponsored by his Division at times and places apart from Conventions of the Society, which served the needs of members interested in this specialty field.

Matters of Public Interest Studied

Technical Divisions carry a responsibility in seeking a solution to the basic problem of "informed public decision," reported Harmer E. Davis, vice-chairman of the Highway Division. "A profession has an obligation to contribute to the solution of public problems, in their larger as well as technical aspects. A collateral factor is that if an organization, in full sense of the word, does not so contribute, it will lose stature as a group in our Society." Professor Davis stated that engineers must steer a clear course between being a pressure group and being a do-nothing group, but emphasized that our Society should not engage in political activity. On a related subject, the facilities for contact of the profession with the general public were described by Don P. Reynolds, assistant to the Secretary of ASCE, who proposed public relations agencies within the Technical Divisions, to assure outlet of news that casts credit on the profession, to both the membership and the general public.

The contact between the Division and its membership is carried on to a certain extent by Division newsletters. C. O. Dohrenwend, chairman of the Engineering Mechanics Division, described the results of a newsletter distributed to the membership of his Division. Currently all Divisions are at least planning newsletters, and such newsletters are now a part of the Journals of several Divisions.

The Journals, which constitute a new publication process, were the subject of extended discussion. The preparation of material for the Journals is the responsibility of the Divisions. As a facility for production of such information, the op-

eration of a Division Committee on Publications was described by Harold M. Martin, secretary of the Hydraulics Division. This Division committee works closely with the technical editors of ASCE. The problems encountered in this rela tionship, and the procedures followed currently were described by Executive Secretary William H. Wisely. The distribution of these Journals is facilitated by a return to the opportunity for members to enroll in two Divisions, a new facility described in detail by Prof. J. M. Garrelts, a member of the Committee on Division Activities.

ASCE'S Part in Standards and Research Is Growing

In the preparation of new standards and the revision of old standards, ASCE participates with other organizations in the work of the American Standards Association, having representation on some 36 committees. Most of these committees deal with specific standards, although some of them are policy forming in nature. This extensive field of operation was described by Clarence A. Willson, chairman of the ASCE Standards Committee, and representative of ASCE on the Standards Council of ASA. It is in the establishment of standards, said Mr. Willson, that the Technical Divisions carry a heavy responsibility for the profession, if the civil engineer's viewpoint is to be expressed when new American Standards are established.

A similar responsibility in the coordination of research was described by Martin A. Mason, chairman of the ASCE Research Committee. Dr. Mason posed three questions to the Technical Divisions: "Are the needs for research in civil engineering being satisfied? Can the civil engineering profession benefit from increased research? Are the Technical Divisions satisfied that they are doing all they can do or should be doing in research?" After earnest soul searching, the Divisions discussed the establishment of new machinery which would make it possible to assume such obligations. The operation of a Division research committee was described by Wallace M. Lansford, vice-chairman of the Hydraulics Division, which has operated such a committee for some time.

Manpower and Funds Needed

To carry out such an extensive program the first need, as described by President Needles in his opening remarks, is for interested and willing manpower. In a résumé of this situation, Robert A. Sutherland, chairman of the Power Division, pointed out ways in which volunteer manpower can be organized for constructive assignments, with special reference to the experience of his Division. One specific relationship studied was the succession of members serving on the executive committee of the several Divisions, which process was described by Francis O. Clark, secretary of the City Planning Division.

The ever-pressing problem of obtaining funds essential to carry on needed activities was described by Frank A. Marston, chairman of the Budget Committee, who led discussion on planning activities of the Divisions to permit sound budgeting. Vice-President Marston pledged the full support of his committee in facilitating the conduct of Division activities, urging early planning as a key to economic operation. Mr. Marston pointed out that the current budget of the Society provides over $101,000 for the support of Technical Division activities, which does not include the expenditures for the publications of the Divisions.

Host for the conference in Kansas City was the Kansas City Section. Louis G. Feil, president of the Section, welcomed the delegates to Kansas City, and presided at a luncheon at the Kansas City Club, which featured a talk by H. Roe Bartle, mayor of Kansas City. Mr. Bartle stressed the dependence of Kansas City upon its engineers, and presented a key to the city to President Needles.

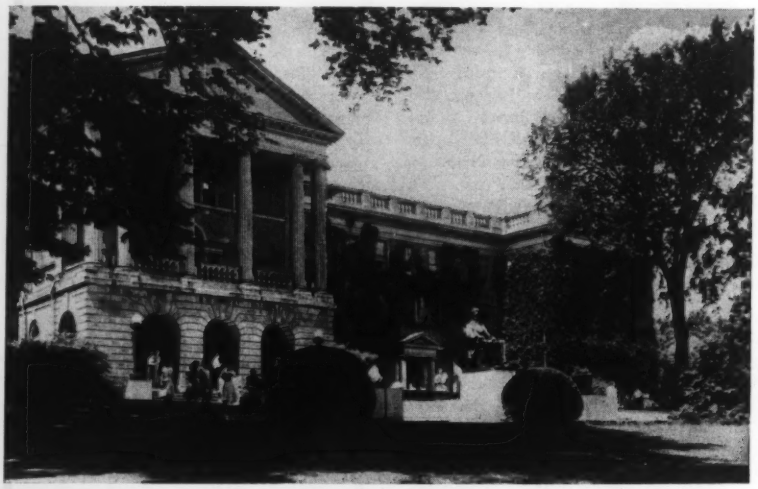
Hydraulics Division Conference to Be Held in Madison

The campus of the University of Wisconsin at Madison will be the picturesque and restful setting for the Hydraulics Division's annual conference, slated for August 22–24. The University of Wisconsin and the Wisconsin Section of the Society will be the hosts.

Madison, on beautiful Lake Mendota, is the center of a world-famed resort area, which should make the conference appealing to the whole family as well as to the more engineering minded members. With this idea foremost, the committee in charge has arranged for room and board for the visitors in university dormitories on the lake shore. Rooms are for single, double, or triple occupancy, as desired. The charge will be $6.00 a day, with half price for children six years old or younger. Madison is small enough so that the usual motels and hotels are conveniently close to the campus for persons preferring those accommodations at higher prices.

Meetings will be held in the air-conditioned Memorial Union Theater adjacent to Lincoln Terrace. Five of the Hydraulics Division committees have prepared programs. They are the Research, Hydrology, Sedimentation, Floods, and Design committees.

Friday afternoon the group will go by bus or private automobile to Milwaukee for inspection of the plant of the Allis-Chalmers Co.—one of the great manufac-



Historic Bascom Hall and Lincoln Terrace crown the University of Wisconsin's famed campus, which will be the meeting place for this year's conference of the Hydraulics Division. To keep the cost of attendance down, board and lodging will be available in university dormitories for those wishing it.

turers of hydraulic turbines, pumps, and other large construction and industrial equipment. Dinner will be served that evening at the Allis-Chalmers Clubhouse, where the group will be guests of the company at dinner. The Milwaukee Braves will have a home game that evening in County Stadium, where they will play the Philadelphia Phillies. The committee has already purchased a block of tickets, and reservations should be sent in early to assure getting the best seats.

In Madison plans are under way for the usual banquet. Entertainment for the ladies and children will promote the family atmosphere. All costs are being held to a minimum to attract Junior Members and their wives back to the campus for a pleasant refresher education.

The Hydraulics Division Executive Committee arranging the program consists of J. B. Tiffany, chairman, and Prof. W. M. Lansford, T. J. Corwin, Prof. C. E. Kindsvater, and Harold M. Martin, secretary. The Madison committee is headed by Prof. Arno T. Lenz, president of the Wisconsin Section. Professor Lenz is assisted by the following committee chairman: Prof. J. R. Villemonte, Registration; Prof. G. A. Rohlich, Housing; R. R. Claypool, Milwaukee Program; Mrs. J. G. Woodburn, Ladies Program; Prof. J. G. Woodburn, Madison Entertainment; F. T. Schaefer, Transportation; Don Johnson, Publicity; and H. A. Goetsch and K. R. Wright, Finance.

Engineering Foundation Grants Go to 27 Projects

A wide range of engineering research will be advanced with new grants appropriated by Engineering Foundation at its annual meeting held in New York on May 3. Allocations for the 1956–1957 fiscal year total $53,000. They will go to twenty-seven projects, which are receiving estimated outside support of $497,500. The projects are being carried out mainly in university, government and industrial laboratories all over the country under sponsorship of the major engineering societies.

Projects receiving funds represent all the major branches of the profession and range from a program for predicting disastrous storm surges, which got under way last year under sponsorship of the American Institute of Mining and Metallurgical Engineers, to a recently instituted three-year research project on the Thermal Resistivity of Soils, which is being co-sponsored by the American Institute of Electrical Engineers, Engineering Foundation, and other groups. Several of the projects are of special interest to ASCE.

This year Engineering Foundation is making a special grant of $5,000 for an important new project of the Reinforced Concrete Research Council. The special program will consist of a four-year investigation of multiple-panel reinforced concrete floors for buildings and will concentrate on the various types of floors made up of slabs continuous in two directions. These types of construction are divided into two categories: (1) slabs supported on beams spanning between columns, and (2) slabs supported only at the columns. Present building codes call for basically different designs for floors with and without beams. The coordinated test program will study the two basic types of structures and their variations, with the ultimate aim of determining if their behavior is sufficiently different to justify existing differences in the bases of design.

In addition to the special appropriation, the Reinforced Concrete Research Council is also receiving a grant toward its regular research program. The Council, which was established in 1948 under sponsorship of ASCE, promises important benefits in reducing the cost of reinforced concrete construction. It has projects under way in a number of university laboratories and at the U. S. Army Engineers Exposure Station at Treat Island, Me., and is currently launching an investigation of medium-strength steel for concrete reinforcement, which will be conducted at Cornell University.

A project started last fall to attack the problem of metallic corrosion, which annually costs industry enormous sums in replacement costs, is also receiving a grant. The newly created Corrosion Research Council of the Engineering Foundation—a project of the AIME, the Intersociety Corrosion Committee, and the Electrochemical Society—will make an all-out effort to help industry in the solution of its No. 1 problem. This it will do by providing more basic scientific data and by encouraging closer cooperation of the interested groups.

In its initial stages the project will include a study of the reactions that take place on the surface of a metal single crystal in pure water containing various amounts of oxygen. Major attention will be paid to the film of adsorbed layers that forms on the metal when it comes in contact with water, and to the role that the film plays in controlling the passage of the metal cations into solution. Copper will be the first metal studied because of its structural simplicity and the ease of preparing single crystals from it. Later when techniques have been developed, the same method will be used to investigate the more complex metals, particularly iron and its alloys. The work will be conducted at the National Bureau of Standards under the general direction of an advisory committee headed by Dr. A. T. Gwathmey, of the University of Virginia.

Our shifting shore lines are being studied in another research program that continues to receive Engineering Foundation support. Though the Council on Wave Research had its origin in the ASCE Hydraulics Division, it is now operating as an independent program. The Council was set up to survey the various fields of water-wave action and related coastal problems, with special attention to the needs of engineers for reliable design procedures. In its six years of existence it has sponsored five Conferences on Coastal Engineering, a Conference on Ships and Waves, and a Conference on Coastal Engineering Instruments. One of its important undertakings has been the compilation of a glossary of terms and a list of standard symbols used in the field. The Council on Wave Research has its headquarters at the University of California.

Engineering Foundation, which was founded in 1914, administers the income from a $1,500,000 fund dedicated to the stimulation of engineering research. This annual income of some $50,000 has had an importance out of all proportion to its relatively modest size. It has been judiciously used over the years to aid in their early stages many research programs that later were able to obtain large-scale financial backing and develop into important projects.

ASCE MEMBERSHIP AS OF MAY 9, 1956

Members	9,159
Associate Members	11,883
Junior Members	17,758
Affiliates	72
Honorary Members	41
Total	38,913
(May 9, 1955	38,313)

Local Sections Sponsor Large Regional Conferences

This spring Local Sections in all parts of the country have been getting together in large regional conferences for discussion of Society operation at both national and local level. Actually some of the conferences turn out to be miniature Society Conventions, with comprehensive technical and elaborate social programs, interesting field trips, and all the other adjuncts of a good convention. Others are briefer workshop sessions.

Pacific Southwest Council

In the category of larger and more ambitious meetings was the ninth annual conference of the Pacific Southwest Council, held in Pasadena, Calif., April 18–21, with the Los Angeles Section as host. An outgrowth of the former California Conference, the present conference includes the Arizona, Intermountain, and Hawaii Sections as well as the four California Sections. The attendance of 400 was headed by President E. R. Needles and Executive Secretary William H. Wisely and the ASCE Executive Committee, which met during the conference.

Two full days of technical sessions were devoted to study of such topics as highway legislation and engineering, water rights and plans, and flood control, and to the nine excellent papers presented by Student Chapter contestants in the annual competition for Council prizes. Congressman Craig Hosmer, of Long Beach, suggested a partnership arrangement as a solution to the water problems of the arid West in the featured speech at the Friday luncheon. One of the high points of the conference was a trip to the U.S. Naval Base at Long Beach. A post-conference trip to Hawaii was sponsored by the Hawaii Section.

Seen at head table at luncheon at U.S. Naval Base at Long Beach, objective of Pacific Southwest Conference field trip, are (left to right) R. Shoemaker, chief engineer, Long Beach Harbor Board; Mrs. C. H. Neel; T. R. Dames; Comdr. A. F. Benscheidt, public works officer, U.S. Naval Base, Los Angeles; Mrs. T. R. Dames; Capt. R. K. James, commander, Long Beach Naval Shipyard; Mrs. Sterling Green; Sterling Green, general conference chairman; Mrs. R. R. Gentry; and Mrs. A. F. Benscheidt.

At head table at dinner concluding all-day meeting of New England Council of Sections are (in usual order) Mrs. Frederick H. Paulson; Senator John O. Pastore, who was featured speaker; Council President Daniel C. Drucker; and ASCE Director Frederick H. Paulson.

The ladies (there were 104 of them) had their own program of sightseeing and other activities. They paid special tribute to Mrs. Franklin Thomas, wife of the late Past-President Franklin Thomas. Sterling S. Green was general conference chairman.

Pacific Northwest Conference

Some 120 members in the Pacific Northwest went to Boise, Idaho, April 27 and 28 for the annual meeting of the Pacific Northwest Conference, to which the Southern Idaho Section was host. One piece of business accomplished was changing the title to the Pacific Northwest Council.

Next year's meeting will be held at Walla Walla, Wash., with the Columbia Section the host. Officers of the 1957 Council will be Leigh M. Huggins, chairman; Glenn von Gunsten, vice-chairman; Clifford R. Salmen, secretary-treasurer; and Harold J. Doolittle, regional historian.

New England Council

The third annual regional conference of the New England Council—held at Brown University, Providence, R.I., on April 7—appealed to a wide range of technical and professional interests. "Modern Developments in Structural Design and Construction" were studied in a two-hour panel discussion. Taking part were James J. Kenney, structural engineer for the Portland Cement Association; Prof. R. M. Haythornthwaite, Brown University; and Prof. Bruno Thurlimann, Lehigh University.

The all-day program included a luncheon meeting, at which ASCE Director Frederick H. Paulson gave a report on Society affairs, and a dinner meeting, at which U.S. Senator John O. Pastore spoke on "The Promise of the Peacetime Atom." There was also a session on the timely topic of civil engineering education in New England. Director Paulson moderated a panel, consisting of Prof. W. S. Evans, of the University of Maine; W. P. Kimball, dean of engineering at Dartmouth College; George A. Marston, dean of engineering at the University of Massachusetts; Prof. John B. Wilbur, of Massachusetts Institute of Technology; and Prof. Daniel C. Drucker, of Brown University. The panel presentation was followed by a discussion from the viewpoint of employers of young engineers.

There were 142 delegates present from all the New England Sections. The Providence Section was host, with Waldo W. Smith, chairman of the Arrangements Committee.

Robert H. Akers, Jun. M. ASCE, member of Cincinnati Section, delivers the paper that won him the Terrell Plaque in the annual Terrell Award Competition.

Line-up in Miami, Fla., where Miami Section was host to District 10 Conference on April 20 and 21, shows (in usual order) James F. Shivler, Jr., Florida; Herbert J. Morrison, president of host Section; W. N. Carey, Executive Secretary Emeritus, Miami; G. P. Willoughby, Director, District 10; E. S. Kirkpatrick, assistant to the Executive Secretary, New York; H. J. Blazek, Nashville; Carlton Conner, Miami; J. M. Faircloth, Alabama; A. E. Johnson, South Carolina; Robert O. Harris, Georgia; James Pou, North Carolina; Kenneth C. Roberts, Alabama; A. T. Ewell, Miami; W. S. Mann, Georgia; Council Chairman John D. Buckley; and W. R. McLean, Tennessee Valley. Except for luncheon on Friday, the two-day program was an intensive business session devoted to ironing out problems of engineer supply and utilization; professional development; professional unity; prestige of the profession; unionization; Section and Student Chapter operation; the ASCE Code of Ethics; specialty boards within the Society; and engineer salaries.

District 9 Council

As usual the big feature of the District 9 Council meeting, to which the Toledo Section was host in Toledo on April 14, was the Terrell Award Competition for Junior Members. This year the young contestants—carefully weeded out in preliminary Local Section competitions—wrote on the subject, "Can Competitive Bidding Provide Professional Engineering Services?" Robert H. Akers, of the Cincinnati Section, was the winner and received the Terrell Award Plaque. Ronald D. Hughes, of the Kentucky Section, placed second, and Porter W. McDonnell, of the Toledo Section, third.

An address on limited access highways by Ruben N. Bergendoff, of the consulting firm of Howard, Needles, Tammen & Bergendoff, featured the annual Council banquet. Society affairs were ably covered by Louis R. Howson, Vice-President for Zone III, and Society headquarters was represented by E. S. Kirkpatrick, assistant to the Secretary. Joseph C. Webber, of Toledo, was Council chairman, and Floyd F. Schrader, of Louisville, was Council secretary.

ASCE Recognizes Student Chapter Work

President Needles has announced the annual awards to Student Chapters for superior work during 1955. The awards consist of 15 Certificates of Commendation and 58 Letters of Honorable Mention. The winners of Certificates for outstanding work and the number of times they have won top honors are the Chapters at:

Virginia Military Institute	(20th time)
Carnegie Institute of Technology	(14th time)
Tulane University	(13th time)
Iowa State College	(12th time)
Northeastern University	(11th time)
New York University	(10th time)
University of Colorado	(9th time)
South Dakota State College	(7th time)
University of Arizona	(6th time)
Georgia Institute of Technology	(5th time)
Massachusetts Institute of Technology	(5th time)
Bucknell University	(4th time)
University of Cincinnati	(4th time)
University of Washington	(3rd time)
University of Notre Dame	(2nd time)

Letters of Honorable Mention for excellent work go to Student Chapters at the following schools:

Alabama Polytechnic Institute
University of Alaska
California Institute of Technology
University of California
The Citadel
Colorado Agricultural and Mechanical College
Cooper Union
Dartmouth College
University of Dayton
Drexel Institute of Technology
Fenn College
University of Florida
University of Hawaii
Howard University
University of Idaho
University of Illinois
Iowa State University
Johns Hopkins University
Kansas State College
University of Kansas
University of Kentucky
Lafayette College
Louisiana State University
University of Louisville
University of Maine
Manhattan College
University of Maryland
Michigan College of Mining and Technology
Michigan State University
University of Michigan
Missouri School of Mines and Metallurgy
University of Missouri
Montana State College
University of Nevada
University of New Hampshire
Newark College of Engineering
North Carolina State College
North Dakota State College

Norwich University
Ohio Northern University
Ohio State University
Oregon State College
Pennsylvania State University
Princeton University
Rensselaer Polytechnic Institute
Rutgers University
Syracuse University
The Agricultural and Mechanical College of Texas
Texas Technical College
University of Texas
Texas Western College Branch (*)

*) Branch of University of Texas Chapter.

Tufts University
Utah State Agricultural College
University of Vermont
University of Virginia
Washington State College
Worcester Polytechnic Institute
University of Wyoming

Three Certificates are authorized for award by the President in each of the five geographical regions into which the present 132 Chapters, two evening divisions, and three branch Chapters are divided for administrative purposes. The number of Letters of Honorable Mention is determined by a formula devised by the Committee on Student Chapters and applied systematically but independently in each region. For activities during 1955, the number of letters varied from ten to thirteen per region.

Competition for these awards is keen. Leaders in the Chapters are providing constantly increasing quality of programs and better understanding of the purpose of the Chapters. Active participation in Chapter work continues to encourage participation in Local Section and Society activities after graduation. Congratulations to the Chapter members responsible for the 1955 awards.

From ASCE Student Chapters

Regional Student Conferences Stress Job Opportunities

Of tremendous importance to successful Student Chapter operation are the regional Student Conferences held annually, and sometimes semiannually, in all parts of the country. Some of the conferences (and the recent California Conference is a case in point) are held in conjunction with a regional conference of Local Sections, or a Society Convention, or a Local Section meeting. Others equally successful are independent of any Society or Section activity. All have more or less the same purpose—briefing senior-class students on career opportunities in engineering and preparing them for work and for professional responsibilities.

This year only a few of the numerous worthwhile conferences concluding the school year have been reported.

California Conference

The California Conference was an important feature of the ninth annual conference of the Pacific Southwest Council held at Pasadena in April (page 72). As usual there was a spirited student paper contest. All nine contestants, carefully selected in preliminary Section competitions, were given two copies each of ASCE Manuals of Practice. First prize, which included a subscription to CIVIL ENGINEERING, went to Don Klein, of Stanford University. Second prize, including a copy of the Centennial Transactions, was awarded to a distaff contestant—Mrs. Frances Walker, of the University of Arizona.

Junior Forum of National Capital Section plays active part in sixth annual Career Conference, held at George Washington University this spring. The conference gave students from nearby Howard University, Catholic University, and University of Maryland a chance to hear of professional opportunities in various fields of engineering. Panel of Junior Forum speakers consisted of (left to right) Merrit O. Chance, who presented the case for airport design and aerial surveys; Robert L. Huck, consulting; Eugene F. Baldi, construction; Kenneth E. Felton, moderator; Milton A. Fischer, government; Harvey L. Segar, sanitary engineering; and Alex J. Hedquist, sales of building supplies.

Maryland-District of Columbia Conference

The versatility of wood as an engineering material and its utility value in product manufacturing were described and demonstrated at the fourteenth annual conference of Chapters in the District of Columbia-Maryland area, held at the University of Maryland in April.

Ralph H. Gloss, structural engineer and secretary of the Timber Engineering Co., discussed the basic principles of the Teco system of engineered timber construction and its advantages in light and heavy construction. Wood research developments in products and processes promising benefits to construction were the subject of a talk by Richard C. Cranch, wood technologist and assistant to the company's director of research. The students were also taken on a tour of the Timber Engineering Company's laboratory, where they had a chance to see numerous wood research projects under way.

S. S. Steinberg, dean of the college of engineering, welcomed the group consisting of some fifty students from four metropolitan Washington universities—Johns Hopkins, George Washington, Howard, and Maryland. David Murray, president of the host Chapter, presided.

Mid-Continent Conference

Early in May the Kansas State College Chapter at Manhattan, Kans., was host to the twelfth annual Mid-Continent Conference of Chapters, which was attended

by delegates from the University of Kansas, Missouri School of Mines, University of Missouri, University of Nebraska, Oklahoma A. & M. College, University of Oklahoma, and the host college. C. L. Eckel, Director of ASCE and dean of engineering at the University of Colorado, was guest speaker at the opening session, with a stimulating talk on "The Civil Engineering Graduate and the Engineering Profession."

A student paper competition resulted in the award of first prize to Del Holm, of Kansas State, who presented an illustrated paper on lift-slab construction and its advantages. Barry Larson, of the University of Nebraska, won second place with a paper on prestressed concrete.

The three-day conference also featured a field trip to Tuttle Creek Dam, now under construction by the Corps of Engineers on the Blue River north of Manhattan; and a banquet, which was addressed by Josef Sorkin, of the consulting firm of Howard, Needles, Tammen & Bergendoff.

Roy Hahn, of the University of Oklahoma, ably presided at all sessions. The success of the conference reflects months of careful planning put in by Martin Eby, Jr., and Monroe Funk, of the host Student Chapter.

Rocky Mountain Conference

Two student paper competitions—a graduate and an undergraduate—were prominent features of the two-day program for the Rocky Mountain Conference. Students from eight colleges attended the conference, which was held at the University of Colorado in Boulder, with Dave Austin presiding. First place in the graduate contest was awarded to Duane Ball, of the host Chapter, who received a bound volume of ASCE Transactions for 1953. Winners in the undergraduate contest were John Kessner, of the University of Wyoming, who received first prize of $20; Curtis Allen, of Utah State, who was awarded the second prize of $10; and Jon Liebman, of the University of Colorado, who received a bound volume of ASCE Manuals of Engineering Practice for placing third.

Career opportunities were reported by Maynard Boring, manpower consultant for General Electric and former chairman of the Engineering Manpower Commission of EJC. Other speakers were Warren Raeder, head of the department of civil engineering at the host Chapter; Herbert Prater, of the Bureau of Reclamation, who described the Big Thompson Project (objective of one of the field trips); and Dr. Slutz, of the National Bureau of Standards, who discussed the International Geophysical Year.

Next year the University of Wyoming will be conference host at Laramie.

NOTES FROM THE LOCAL SECTIONS

(Copy for these columns must be received by the tenth of the month preceding date of publication.)

Up in Alaska the **Anchorage Branch** of the **Alaska Section** continues active. At a recent meeting Leo H. Saarella, secretary of the Territorial Board of Engineer and Architect Examiners, explained the present laws governing engineering practice in Alaska to a good-sized group. Because of the intense interest shown, the president appointed a Task Committee on Engineering Legislation consisting of William Page, Charles Clark, Carl Steeby, and David Sivyer. The Branch cooperates with the Anchorage Post of the Society of American Military Engineers in awarding an annual $250 joint scholarship to a local high school student matriculating in engineering at the University of Alaska.

The **Central Illinois Section** sees as one of the most encouraging changes in its operation "the gradual but steady increase of out-of-town members at the various meetings". . . even on some of the worst evenings, weatherwise.

Where the civil engineer fits into the proposed national highway program was the theme of an interesting talk given by President Needles at the April meeting of the **Cincinnati Section.** President Needles also addressed a special meeting of the University of Cincinnati Student Chapter, called to honor two members who have been awarded Lincoln Arc Welding Foundation scholarships of $250 each. The winners are Andrew Barkocy, of Allentown, Pa., and John Gaunt, of Evansville, Ind.

The immense undertaking of building a steel mill in Brazil engrossed members of the **Duluth Section's Iron Range Branch** at a recent meeting in Virginia, Minn. Guest speaker J. Gibson, erection superintendent for Bethlehem Steel, covered the problem of transporting machinery and material from the United States, training unskilled natives to do skilled work, and actual erection of the plant without all the necessary modern equipment.

Members of the Georgia Institute of Technology Student Chapter were responsible for the **Georgia Section's** May

Pictured at recent joint meeting of Cleveland Section and Case and Fenn Student Chapters are winners of Section's Junior Membership awards and Faculty Advisers at the colleges. They are (left to right, large photo) Ernest C. Harris, chairman of civil engineering department at Fenn College; Raul Alamar, Fenn senior; Edward Monarchi, Case junior; and George E. Barnes, professor of hydraulics and sanitary engineering at Case. In small photo G. Brooks Earnest, president of Fenn, presents first G. Brooks Earnest ASCE Junior Membership Award to Case Institute senior, James I. Taylor. Dr. Earnest set up award bearing his name with gift purse received from Cleveland Section in recognition of his five years of service on ASCE Board of Direction.

Engineered for

World's most heavily traveled turnpike

The 118-mile New Jersey Turnpike, constructed with modern asphalt pavement, carried 25,888,319 cars and trucks in 1955. No other turnpike is so heavily traveled, yet this asphalt-paved superhighway is one of the safest heavy-duty roads in the world. Its 1955 safety record of 2.76 fatalities per 100 million vehicle-miles is far better than the 6.5 average for national highways.

ASPH

smooth, rugged service!

IN FOUR SHORT YEARS total traffic volume on the asphalt-paved New Jersey Turnpike has exceeded the total carried during the 15-year life of the Pennsylvania Turnpike, the grand-daddy of present-day toll roads.

Yet in spite of carrying more traffic than any other turnpike in the world, maintenance costs are low and the asphalt pavement is in excellent condition.

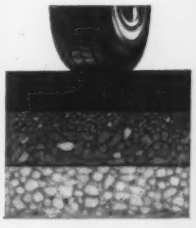
To highway engineers the New Jersey Turnpike's record of tremendous traffic and outstanding safety is a remarkable demonstration of the dependability of modern asphalt pavements for rugged, heavy-duty service.

Modern asphalt pavement saved $50,000 a mile on the New Jersey Turnpike. For one thing, material costs were less because, as is usually the case with asphalt construction, economical use was made of local soils and aggregates. This is one of the many benefits of asphalt's versatility. Also, asphalt construction is faster. Thus the road begins to earn revenue sooner.

Modern, heavy-duty asphalt construction is demonstrating that it offers economy, durability and ease and speed of construction. That's why more engineers are recommending asphalt pavements—engineered for smooth, rugged service.

Engineered for rugged wear

TYPICAL SECTION showing modern 4½" asphaltic concrete pavement on New Jersey Turnpike. Pavement structure designed from the ground up for axle loads of 36,000 lbs. Bids on asphalt design were $5,000,000 less than bids for 10" rigid pavement to carry the same loading.



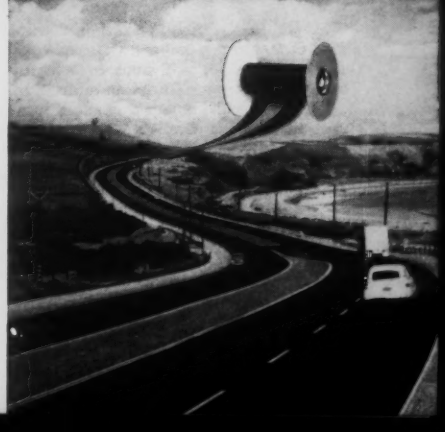
4½" Asphaltic Concrete
7½" Asphalt Penetration Macadam
6½" Compacted Stone or Gravel Subbase

THE ASPHALT INSTITUTE
Asphalt Institute Building, College Park, Maryland

ALT

FOR MODERN HEAVY-DUTY HIGHWAYS

RIBBONS OF VELVET SMOOTHNESS..



As part of a constructive program to make students think, the University of Delaware's civil engineering department assigned senior students a hypothetical four-month design and consulting project that attracted wide attention. Explaining the project to August F. Walz, Mayor of Wilmington (center), are Student Chapter members William C. Craig and Alfred Layton (at left). At right are City Engineer Edwin F. Koesler and Joseph F. Staley, president of Delaware Section. The problem posed to a class in civil engineering planning involved redevelopment of entire navigable Wilmington waterfront area.

program. James B. Cordell moderated a panel-type presentation, in which Eugene A. Mann discussed converting sea water into fresh water; George D. May told how plastic design can save money; J. R. Harding presented a novel irrigation idea; and Robert C. Kirk explained the use of computers for earthwork quantities. Over in Augusta M. P. Phillips, city engineer and commissioner of public works, addressed the April meeting of the **Central Savannah River Valley Branch** on the highway program of Augusta and its vicinity.

Soil engineering problems of the Arctic were discussed at a recent joint meeting of the **Iowa Section** and the Iowa State College Student Chapter. The speaker—R. L. Handy, research associate at the Iowa State Engineering Experiment Station—brought his talk home to the large student audience by reference to the work of Iowa State civil engineers and geologists who have made two trips to Alaska to study the deposition and distribution of wind-blown soil loess.

The **Kansas Section** is working toward a goal of 100 new members. There is also talk of establishing a Branch in Wichita. The April meeting featured an address by E. J. Kersten, chief engineer of the Kansas Gas and Electric Co., on the electrical power picture, "today and tomorrow." Mr. Kersten's review of future needs took into account atomic power sources.

Federal highway aid was the theme of a recent meeting of the **Maine Section's New Hampshire Branch.** Among the speakers were Fred Auer, planning engineer for the New Hampshire Highway Department, who discussed the effects of past and proposed federal highway legislation upon the state, and Robert Johnson, assistant division engineer for the Albany office of the Bureau of Public Roads, who described the functions of the Bureau and the methods of apportioning federal aid. Though one of the youngest Society groups, the **Vermont Branch** entered the newsletter field in April with Vol. 1, No. 1 of an interesting mimeographed monthly.

David G. Baillie, Jr., partner in the New York firm of Singstad & Baillie, will succeed Richard Hazen as head of the 3,600-member **Metropolitan Section.** Other new officers—elected at the Section's last meeting of the season on May 16—are Richard H. Tatlow 3rd, vice-president for two years; Arthur J. Fox, Jr., secretary for two years; and John M. Buckley, Robert H. Dodds, and Martin S. Kapp, directors for two years. The Section also presented the Robert Ridgway Awards given annually to superior civil engineering students in the schools of the area. This year's winners of the awards, which honor the late Robert Ridgway, Past-President of ASCE, are John Schmuck, Brooklyn Polytechnic Institute; Richard H. Schwartz, College of the City of New York; Arnold S. Vernick, Columbia University; Gener Ostertag, Cooper Union; John C. Totten, Manhattan College; John S. Urban, Newark College of Engineering; Dominick Montalbano, New York University; and Wilbur H. Schlimeyer, Rutgers University.

David Baillie

Responsibilities of architects and design engineers in present-day construction were covered in the leading talk at a recent meeting of the **Billings Branch** of the **Montana Section.** John E. Toohey, president of the Montana Chapter of the American Institute of Architects, stressed that "architects and engineers must work hand in hand in many of the complex operations in the design of a building."

On the agenda for the April meeting of the **National Capital Section** were talks continuing the operation and maintenance theme the Section has been studying in recent technical programs. The maintenance work of the Corps of Engineers, which comes to $90,000,000 annually (about one-fifth of its annual construction budget), was reviewed by Joseph M. Caldwell, of the Beach Erosion Board. Mr. Caldwell called attention to current research programs designed to reduce maintenance costs. These include sodding of levees, improvement in revetment design, and control of water hyacinth by spraying. He said electronic computers are being used to work out coordinated operation of a system of reservoirs, and that research into the life of sheet-steel piling, timber, and other materials under conditions peculiar to the operations of the Corps is actively under way. In a similar survey of Bureau of Reclamation operation and maintenance work, Thomas Maddock, Jr., hydraulic engineer for the Bureau, concentrated on its multiple-purpose water-resource projects. As Mr. Maddock sees it, the biggest problem in the operation of such projects is dealing with people. "Organization of the area concerned at the proper political level is also important," he stated.

The Minneapolis-St. Paul Metropolitan Airport system, consisting of six separate airports, was the subject of the **Northwestern Section's** April meeting. The speakers—Royce B. Hansen, of Toltz,

Scheduled ASCE Conventions

PITTSBURGH CONVENTION
Pittsburgh, Pa.
William Penn Hotel
October 15–19, 1956

JACKSON CONVENTION
Jackson, Miss.
Hotel Heidelberg
February 18–22, 1957

BUFFALO CONVENTION
Hotel Statler
June 3–7, 1957

Paves 26,000-vehicle-a-day boulevard with hot-mix Texaco Asphaltic Concrete

Governor Printz Boulevard in Wilmington, Del., one of numerous major traffic arteries throughout America to be paved with heavy-duty Texaco Asphaltic Concrete.

CONTRACTOR
George and Lynch
Wilmington, Del.

ENGINEERING · RESEARCH · EDUCATION · THE ASPHALT INSTITUTE · MEMBER

Governor Printz Boulevard in Wilmington, Del., is one of that State's most important traffic arteries. Last year, when the average 24-hour traffic on the boulevard passed 26,000 vehicles, steps had to be taken to relieve congestion.

The boulevard has since been widened, then resurfaced completely with a hot-mix, hot-laid wearing surface of Texaco Asphaltic Concrete, spread to a compacted thickness of three inches.

Texaco Asphaltic Concrete is a heavy-duty pavement, whose resilient, flexible qualities enable it to absorb punishing impact year after year with a minimum of upkeep. It is the ideal pavement wherever *heavy* traffic must be served, including turnpikes, vehicular tunnels or bridges, important city streets and trunk highways.

In addition to rugged durability and low maintenance cost, Texaco Asphaltic Concrete has other important advantages for road builder and motorist. It is ready for traffic as soon as compacted. Its highly skid-resistant texture and the sharp visibility of traffic lines on its dark surface are important aids to safe driving. Its resilience and freedom from joints insure lasting driving comfort for motorists.

Helpful information concerning Hot-mix Asphaltic Concrete is supplied in the booklet, "Texaco Asphalt Paving—Plant-mixed Types." This free publication can be secured without obligation by writing our nearest office.

TEXACO

THE TEXAS COMPANY, Asphalt Sales Div., 135 E. 42nd Street, New York City 17
Boston 16 • Chicago 4 • Denver 1 • Houston 1 • Jacksonville 2 • Minneapolis 3 • Philadelphia 2 • Richmond 16

TEXACO ASPHALT

ASCE President Enoch R. Needles visits Sacramento Section. Shown here (left to right) are Thomas E. Stanton, Fred W. Panhorst, ASCE Director R. Robinson Rowe, President Needles, and Section President Francis N. Hveem. President Needles brought the group up to date on major problems facing the profession at the Section's 1,634th regular luncheon meeting on April 17. The large audience included a number of Section past-presidents.

At meeting of St. Louis Section Merle A. Banta (second from right) finally catches up with the Daniel Mead Award for Junior Members, which was awarded him last year. Navy service prevented Mr. Banta's accepting the award earlier. Notables present at the meeting are (in usual order) ASCE Director Don Corbett; Neal J. Campbell, president of the Section; ASCE President Enoch R. Needles; ASCE Vice-President Louis R. Howson; Mr. Banta; and Executive Secretary William H. Wisely.

King, Duvall, Anderson & Associates, Inc., and Robert Aldrich, executive secretary of the Metropolitan Airports Commission—discussed the operation of the system, with special attention to Wold Chamberlain Field, which handles most of the commercial passenger traffic. During the past year 1,110,000 passengers were handled at this busy field, and it is expected that by 1965 the number will have increased to 2,500,000.

In the "machines of tomorrow" we may expect shovels with 100-cu yd dippers for projects of great magnitude. This is what R. G. LeTourneau, famed designer and manufacturer of heavy equipment, told members of the **Panama Section** in the featured talk at a recent meeting. Mr. Le Tourneau described some of the machines and methods he is using in land-clearing and road-building operations in Africa and Peru, and stressed the need for vision and daring in the development of new machines for large jobs. Members of the Panama Society of Engineers and Architects and the Society of American Military Engineers were guests of the Section.

The **Rochester Section** was host in April to the first meeting of the newly organized District 3 Council. Executive Secretary W. H. Wisely and E. S. Kirkpatrick, assistant to the Secretary, were present from ASCE Headquarters to head discussion of Society affairs.

Special design features of the new Atomic Research Center to be built in San Diego were discussed at a recent meeting of the **San Diego Section** by Wade L. Fife, physicist with the General Dynamics Corp. Some of the Nation's top physicists and scientists will be associated with the center, which will be started late this year. The architect-engineer firm of Pereira and Luckman has been selected as designer.

Texas engineers interested in water turned out en masse for a recent joint meeting of the **Austin Branch** of the **Texas Section** and local groups of the Founder Societies, the American Welding Society, and the Texas Society of Professional Engineers. Marvin C. Nichols, Fort Worth consultant and member of the Texas Legislature's Water Resources Committee, told the joint assembly that the state water program is moving forward satisfactorily on a broad front. As evidence of the attention the subject is receiving, he cited the large number of dams either being built or in the planning stage and the formation of underground water districts. The greatest need at present, according to Mr. Nichols, is for more basic data, such as topographic maps and stream-gauging records. Members of the **Fort Worth Branch** heard a good talk on the proposed highway program, by E. A. Bossey, district engineer for the Texas Highway Department, at their April luncheon meeting. Ben H. Anderson, 2918 Magnolia Street, Beaumont, Tex., is secretary-treasurer of the **Southeast Branch.** He replaces Jack D. Morris, who has been transferred by his employer to New Orleans.

The function of the Corps of Engineers in basin planning and development was the theme of a recent meeting of the **Tri-City Section,** held jointly with the Iowa City Section and the Department of Mechanics and Hydraulics at the University of Iowa. Featured speakers were Lt. Col. Robert D. Brown, of the Corps of Engineers, and Jack A. Gardner, supervising hydraulic engineer for the Corps.

Coming Events

Illinois—Luncheon meetings at the Chicago Engineers Club (314 S. Federal Street) every Friday noon in June.

Sacramento—Weekly luncheon meetings at the Elks Temple every Tuesday at 12 noon.

Spokane—Section will be host to the ASCE Irrigation and Drainage Conference, to be held at the Davenport Hotel, Spokane, September 6–8. Program will include two days of technical sessions and a field trip (on the 8th) to Columbia Basin drainage and irrigation installations.

Wisconsin—Tour of Oak Creek Power Plant on June 21. Section will be host to the ASCE Hydraulics Division Conference, to be held at the University of Wisconsin, Madison, August 22–24 (see page 70).

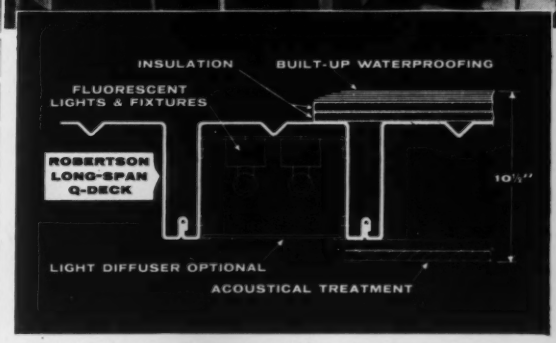
Robertson Long Span Q-Deck
cuts cost 3 ways in School Construction

1 Extra-strong Long Span Q-Deck is an ideal material for use in "reduced budget" school construction because it saves time and basic materials. Spans up to 32 feet completely cover classrooms and include corridors or outside cantilevered walkways thus reducing labor and structural steel.

2 Long Span Q-Deck used as a ceiling possesses a measure of acoustical benefit, therefore only perimeter treatment of acoustical material becomes necessary as seen in the photograph. This again saves time and material.

3 Flush lighting can be installed within the cells of Long Span Q-Deck to produce an extremely attractive, efficient, low-cost lighting system, as shown in the photograph and detail to the right. Use the coupon to write for further details on this remarkable deck — designed for multiple, money-saving benefits.

ROBERTSON LONG SPAN
Q-DECK



With this 3-way system, only 10½" of depth is required for the entire roof and ceiling section.

H. H. Robertson Company

2440 Farmers Bank Building • Pittsburgh 22, Pennsylvania

In England—Robertson Thain Ltd., Ellesmere Port, Cheshire
In Canada—Robertson-Irwin Ltd., Hamilton, Ontario

Please send additional information on Long Span Q-Deck.

NAME _____ TITLE _____

COMPANY _____

ADDRESS _____ CITY _____

NEWS BRIEFS . . .

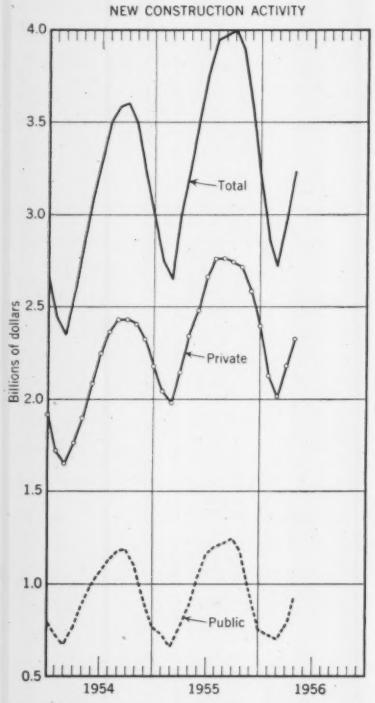
Construction Activity Continues Seasonal Advance in April

Outlays for new construction expanded seasonally in April to $3.3 billion, matching the all-time April high achieved in 1955, according to preliminary joint estimates of the U. S. Departments of Commerce and Labor. The 9 percent April increase over the preceding month brought expenditures for the first four months of 1956 to $11.8 billion, the same January–April figure reached last year.

Most of the April increase resulted from seasonal gains in private residential building and highway construction. Spending for highway construction, up 4 percent from 1955, established a new record for the month, but outlays for private residential building were off 8 percent from last year's unprecedented level. Private industrial building rose somewhat more than seasonally to surpass the volume for any previous month. Commercial building, at an all-time high for April, was 18 percent above last year. Sewer and water facilities also set a new April record.

In the first four months of 1956, private expenditures for new construction totaled $8.7 billion, and public expenditures $3.1 billion. Both amounts were virtually the same as the 1955 totals for the corresponding period, though there have been shifts over the year in the various construction components. Types of construction showing the most significant 1955–1956 advances, when the first four months are compared, were private industrial building (22 percent); commercial building (25 percent); and public service enterprises (115 percent). The latter category received a considerable boost from work under way on the power and other facilities connected with the St. Lawrence Seaway.

The greatest relative decrease from 1955 (59 percent) was in public industrial construction, resulting from a continuation of the decline in construction of atomic energy facilities that began early in 1954.



Construction totaling $3.3 billion, put in place in April, represents a 9 percent increase over March expenditures and matches the all-time April 1955 high.

However, the most important decline, dollarwise, was in private housing, which was off $340 million (8 percent) over the year, when the January–April periods are compared.

Water Is Too Cheap, AWWA Told

Water-works engineers were told that they should *not* be proud of the fact that "water is cheaper than dirt"—that is, 5 to 10 cents per ton. Addressing the Diamond Jubilee Convention of the American Water Works Association at the Municipal Opera House in St. Louis on May 10, John H. Murdoch, Jr., chief counsel for the American Water Works Co., Philadelphia, said that today an average customer's water bill for a year can be paid for by one day's labor. Water has been low priced so long that Americans naturally resist efforts to pay for needed expansions to systems. "We should be ashamed of too cheap water," he concluded.

A near-record attendance of 2,538 water-works engineers and manufacturers gathered for the celebration of AWWA's diamond anniversary in St. Louis, where the organizational meeting was held 75 years ago this spring. One feature of the week-long convention was the installation of Paul Weir, M. ASCE, general manager of Atlanta's Water Department, as president, and of Fred Merryfield, M. ASCE, professor of sanitary engineering at Oregon State College, as vice-president.

Missouri River—a Major Water Supply Source

St. Louis and the surrounding residential and industrial communities on both sides of the Mississippi have this river, plus the Missouri which joins the Mississippi 15 miles above Eads Bridge and the Meramec which enters 16 miles below, as their principal sources of water supply. Professional papers describing the facilities for pumping, treating, and distributing water to this important area, which has a population of 1,750,000, constituted an important part of the technical program. One of the newest plants to be placed in operation, and the goal of an inspection trip, is the 36-mgd North County Plant of the St. Louis County Water Co. Water from the often very muddy Missouri is treated in this $5,000,000 plant by preliminary sedimentation, primary and secondary settlement, and by filtering through a battery of six sand filters at 3 gpm per sq ft of filter area. Distribution is through a 36-in.-dia transmission line.

A panel of experts on the Missouri River, composed of engineers from the federal, state, and municipal levels of government, agreed that the six major reservoirs on the river in Montana and the Dakotas already in operation or now under construction will provide a degree of control having no counterpart in the river basins of the world, except the planned program for the Colorado River and the contemplated control of the Nile. Fort Peck, Garrison, and Fort Randall dams, already in operation, provide nearly, 50,000,000 acre-ft of storage. When Oahe Dam is completed the main-stem storage will be increased to 73,000,000 acre-ft, or three times the annual flow of the Missouri measured at Sioux City. These multiple-purpose dams provide flood control, irrigation, navigation, power generation, plus domestic and industrial water supply and downstream abatement of sewage pollution.

From a water-supply standpoint, Wendell E. Johnson, M. ASCE, chief engineer of the Missouri River Division of the Corps of Engineers, pointed out that the great and desirable reduction in turbidity has had the side effect of an increased growth of plankton in the water because sunlight can now penetrate deeper into the reservoirs. Taste and odor removal problems result. Twenty-four public water supplies, serving a total population of more than 2,000,000, draw water from

the river, principally in the vicinities of Omaha, Kansas City, and St. Louis. A major program of cleaning up the river by sewage and industrial waste-treatment facilities, estimated to cost upward of $100,000,000, has been initiated by a five-state conference of officials.

A major address, "The Nation's Water Resources," was made by Assistant Secretary of the Interior Fred G. Aandahl, former governor of North Dakota. Governor Aandahl emphasized and discussed the major features of the Report of the Presidential Advisory Committee on Water Resources Policy. "The policy of this administration," he said, "can be summed up in a word—partnership. It means that the federal, state, and local participants will cooperate in solving their water resources problems, and in addition it means that each will assume some of the responsibilities as well as the costs of carrying out such programs." The report proposes establishment of an Office of Coordinator of Water Resources in the Executive Office of the President, and a full-time impartial Board of Review to evaluate the economic and engineering feasibility of projects before submittal to the President. Mr Aandahl recommended the report as a guide for proper federal activity in relation to our water resources.

Water Works Management

Answers to the panel question, "Shall recreational uses of water-works-impounding reservoirs be permitted?" were almost unanimously, "No." The opinion appeared to be that no fishing should be allowed unless a filter plant is in existence. Reliance on chlorination alone is not safe.

Universal metering of Philadelphia's 500,000 water services will be an accomplished fact by the end of 1956. This is the largest city so far to undertake such a huge task, said Samuel S. Baxter, M. ASCE, water commissioner of that city. The financing of the program was handled by a bond issue, but the full cost of purchasing and installing 180,000 new meters and repairing 30,000 old ones is charged to the property owners.

Exhibits of Equipment

A feature of the convention was an attractive exhibit by 100 manufacturers and distributors of water works equipment, materials, and services sponsored by the Water and Sewage Works Manufacturers Association, associates of AWWA. It received much attention.

The chairman of the Convention Management Committee was Victor Weir, M. ASCE, president of the St. Louis County Water Co. The program was arranged by Richard Hazen, M. ASCE, consulting engineer of New York. Much credit was given to Harry E. Jordan, Aff. ASCE, secretary of the AWWA, for the successful outcome of the Diamond Jubilee.

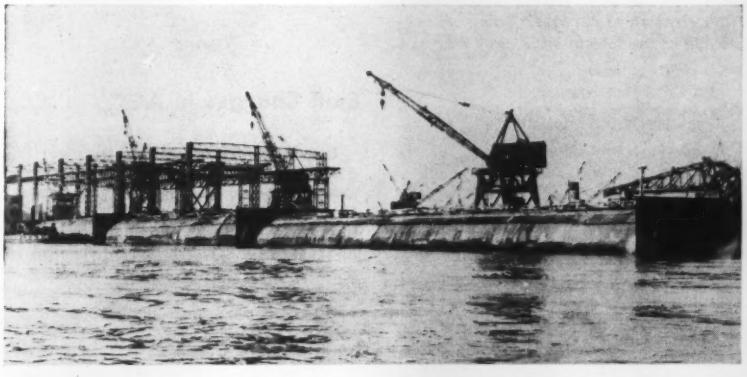
American Gas Co. Plans Giant Generating Units

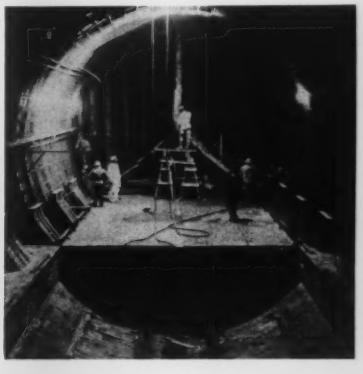
Plans for building two 450,000-kw coal-burning steam-electric generating units—the largest in the history of the electric power industry—are announced by Philip Sporn, M. ASCE, president of the American Gas and Electric Service Corp. The two units will be installed on the power systems of two of the three largest companies in the American Gas and Electric System—the Appalachian Electric Power Co., the Ohio Power Co., and the Indiana & Michigan Electric Co.—the exact sites to be announced later. Each will cost about $55,000,000.

According to Mr. Sporn, the units will attain a new level of efficiency in the production of electric power. Each will have the equivalent of more than 600,000 hp. They will be 73 percent larger than any single power unit in operation today, and will be capable of supplying all the residential electric requirements of a city with a population of 4,000,000. Coal consumption will be at the rate of 1,300,000 tons a year per unit.

Both boilers will be of the outdoors type, as high as a 23-story building, and will exhaust to an individual poured-concrete stack approximately 500 ft above ground level. They will be built by the Babcock & Wilcox Co., and the turbine generators will be built by the General Electric Co.

Twin-Tube Tunnel Sections Fabricated for Baltimore Harbor Crossing





Three of the twenty-one 300-ft twin-tube sections that will make up the four-lane, trench-type, vehicular tunnel being built beneath the Patapsco River section of Baltimore Harbor are shown afloat at the contractor's "shape-up" basin near the tunnel site. Sealed at each end with watertight bulkheads, the sections are lined with inner rings of concrete and fitted with roadway slab, then towed into position, and sunk into a trench dredged across the river bottom. The first of the sections was recently lowered into position adjacent to the ventilating shaft on the Fairfield side of the river. Small view shows interior concreting of one of the tubes. The twin-tube sections are being fabricated at three different shipyards under contract from Merritt-Chapman & Scott Corp., which is building the 6,300-ft tunnel, together with a ventilating shaft at each end, under a $29,894,081 low-bid contract. Project was designed by Singstad & Baillie, of New York, with the J. E. Greiner Company, of Baltimore, the consulting engineers. Details of the tunnel, which will be ready the end of 1957, were discussed by Ole Singstad, M. ASCE, in the October 1955 issue.

Hiwassee Dam Has Largest Reversible Pump-Turbine Unit

Last month the largest reversible pump-turbine unit in the world went into full operation at the Tennessee Valley Authority's Hiwassee Dam. The key feature in a unique plan for storing large blocks of power, the unit is the first instance in the Western hemisphere of a reversible pump turbine installed for the initial purpose of helping to level system load curves. It was designed and built by the Allis-Chalmers Manufacturing Co.

Electrically, the dual-purpose machine is rated 70,000 kva as a hydraulic turbine-generator and 102,000 hp as a pump-driving motor, making it the world's largest by more than 20,000 hp. Hydraulically, it is designed to generate 80,000 hp under a 190-ft head and to pump 3,900 cfs against a 205-ft head. Rotation is clockwise for generating, counter-clockwise for pumping.

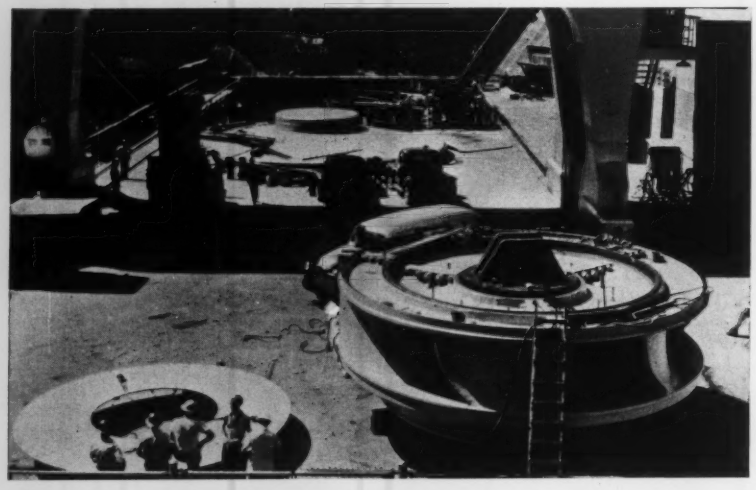
In pumped-storage systems, the reversible pump-turbine unit, developed by Allis-Chalmers, can generate electric power to help meet peak day-time demands, drawing on water stored for that purpose. In off-peak hours, the supply of available electric power exceeds the normal demand. The machine can then be motorized to pump water back into the storage reservoir. It is, in effect, the means by which surplus electrical energy can be converted to water power, stored and reconverted when needed to fill electric power requirements. With the large reversible pump-turbine units, approximately 3 kw can be generated for every 4 kw used for pumping. The Hiwassee unit will assure maximum plant capacity during seasonal peak-load periods when water level is normally low.

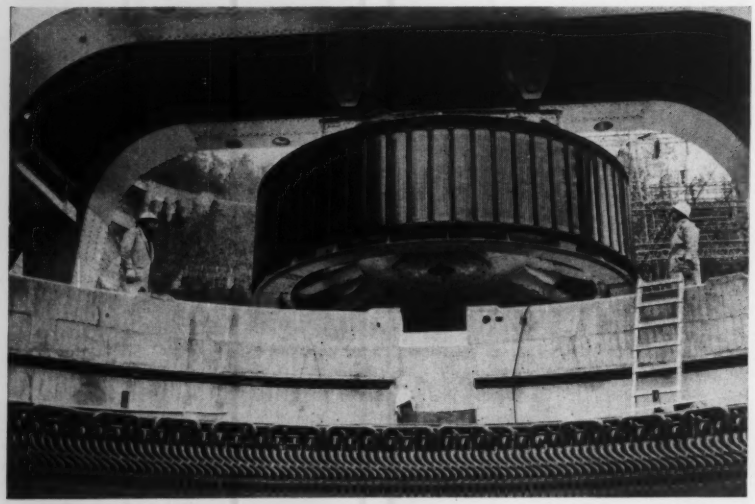
The new machine boasts many record breakers. In addition to being the world's largest pump-turbine, its 266-in. Francis-type runner is larger in diameter than any other. The electrical component, rated 102,000 hp as a motor, has no equal. If the full pumping capability of the unit were utilized over a 24-hour period at lower than rated head, it could lift more than $3^1/_4$ billion gallons of water—three times the average daily requirement of New York City.

Significantly, although it is a relatively new concept, components of the reversible pump-turbine are little different from those already incorporated in many vertical hydroelectric machines. The pivoted shoe-type thrust bearing, for example, is inherently suited for reversible operation. That for the Hiwassee machine supports a total of 1,365,000 lb.

Shipping a unit as large as the Hiwassee Dam installation is a major problem. The 266-in. turbine runner, for example, was built and shipped in three sections, and bolted together at the job site. By contrast, the largest runner of this type that could be handled as a single shipment would be rated 48,000 hp, compared to 80,000 hp for the installed runner.

The record installation was discussed by Reed A. Elliot and Don H. Mattern, Members ASCE, in an article in the March 1953 issue.





Upper view shows assembled three-piece runner for world's largest pump-turbine unit on deck of outdoor powerhouse at Hiwassee Dam. With a diameter of 266 in. and weight of 250,000 lb, unit is the largest Francis-type runner ever built. Pictured below is the rotor for the world's largest motor suspended during erection at Hiwassee Dam. A portion of the coils and lamination of the stator are visible in the foreground. Key-way can be seen in the base of the 330-in., 305-ton rotor.

Staff Changes in AGC

Frank J. Rooney, president of the Associated General Contractors of America announces several changes in the organization's national staff. To relieve Managing Director H. E. Foreman, who has been obliged for reasons of health to decrease his activities, James D. Marshall has been given the full responsibility and authority of chief executive in the management of the association. Mr. Marshall will retain the title of executive director, which he has held since 1953. He has been on the AGC staff for the past seventeen years. Other advancements include William E. Dunn to the post of assistant executive director, and Charlson I. Mehl as administrative secretary.

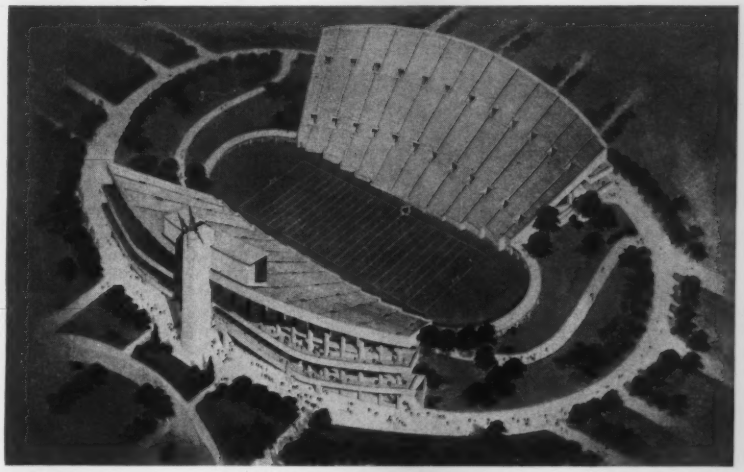
Relieved of the more routine duties of his post, Mr. Foreman will continue under the title of managing director. He will serve in the important post of consultant and adviser on high-level policies, trends, and economic developments.

Kansas Turnpike Work Nears Halfway Mark

With about six months to go before the scheduled opening of the Kansas Turnpike next October, construction advances are showing a big upswing, according to a recent progress report. As of April 1, engineers estimated the actual construction progress at 42 percent of completion, a gain of 6.5 percent over the 35.5 percent estimated completion point of a month earlier. As of the same date, 89 of the 264 bridges involved in the project were completed, and 136 miles of highway had been accepted from the grading contractors as ready for use. All the design and planning phases of the work are finished.

Engineers on the project are Howard, Needles, Tammen & Bergendoff, of New York and Kansas City.

Indiana University to Have 55,000-Seat Stadium



Impressive feature of Indiana University's proposed expansion program is 55,000-seat reinforced concrete stadium shown here in architect's rendering. Stadium and related facilities, consisting of field house and 17,000-seat baseball arena, will be located on a 160-acre tract near the Bloomington campus. Parking space for 14,000 cars will be provided around the perimeter of the stadium so that persons attending games will have direct access to the stadium by means of ramps after parking their cars. Eggers and Higgins, supervising architects for Indiana University, are also architects for the expansion plan. Severud, Elstad & Krueger are structural engineers for the stadium, arena, and field house, and Syska and Hennessy are the mechanical engineers.

New Aluminum Plant to Be Built in Indiana

Plans for building a new 150,000-ton smelting plant in Indiana are announced by the Aluminum Company of America, the nation's leading producer of aluminum. The smelter and a 375,000-kw steam power plant, fired by coal, will be built about 18 miles east of Evansville on the Indiana side of the Ohio River. Cost of the project will be about $80,000,000.

First production from the new plant is scheduled for the fall of 1957, using interim power from the Southern Indiana Gas & Electric Company. Fully integrated operation of the smelter on its own power is expected by mid-1958.

AEC Issues Permits for Private Nuclear Plants

The first permits for private construction of large-scale nuclear power plants have been authorized by the Atomic Energy Commission, according to an announcement from Chairman Lewis L. Strauss. The two large utilities receiving permits are the Consolidated Edison Company, of New York, and the Commonwealth Edison Company, of Chicago. Each permit allocates special nuclear material to be made available over a 40-year period for use as reactor fuel.

Consolidated Edison plans a $55,000,000 plant, which will use nuclear and conventional fuels in combination to generate 236,000 kw of electricity. The plant will be built on a 350-acre site along the Hudson River at Buchanan, N.Y., about 25 miles north of New York City. Babcock and Wilcox will design and build the reactor, which will be of the pressurized water-converter type. It is scheduled for completion by October 1, 1960.

The Commonwealth Edison plant will cost $45,000,000 and will have a net generating capacity of 180,000 kw. It will be built on a 950-acre site at the junction of the Kankakee and Des Plaines rivers, about 50 miles southwest of Chicago. The dual-cycle boiling water reactor will be designed and built by the General Electric Company, with the Bechtel Corporation as engineer. A completion date of September 30, 1960, is stipulated in the construction permit.

The purpose of both projects is to demonstrate the value of nuclear power reactors for commercial purposes.

North Carolina Dedicates Big Power Development

Dedication of the Virginia Electric and Power Company's $32,000,000 hydroelectric development took place at Roanoke Rapids, N. C., in April. Several thousand persons attended the dedication, which marked the addition of 100,000 kw of electric power to Virginia Electric's system. The dam site is on the Roanoke River, ten miles south of the Virginia line and a few miles downstream from the John Kerr Dam, across the same river.

The Roanoke Rapids project includes a 3,050-ft concrete dam; a power station with four 35,000-hp turbines; and a tailrace $1^1/_2$ miles long, 45 ft deep, and 80 ft wide, blasted from solid rock.

Thomas Walsh, Jr., Named President of the Moles

Thomas J. Walsh, Jr., president of the Walsh Construction Co., was elected president of the Moles, New York society of tunneling and heavy-construction engineers, at the organization's annual meeting held in New York on May 1. He succeeds A. Holmes Crimmins, treasurer of the Thomas Crimmins Contracting Co.

Other officers elected were Richard A. Johnson, of the Arthur A. Johnson Corp., first vice-president; Howard A. Collins, of the Howard Collins Construction Co., second vice-president; Gilbert M. Serber, M. ASCE, of the Stock Construction Co., secretary (reelected); and Richard M. Johnson, of the Foundation Co., treasurer.

U.S. Chamber of Commerce Holds Annual Meeting

Quick action on the Hoover Report recommendations for curbing excessive government spending was urged at the 44th annual meeting of the Chamber of Commerce of the United States, held recently in Washington. In the keynote address, Chamber President Boyd Campbell emphasized that putting these recommendations into effect is one way of "improving the business climate."

Said Mr. Boyd, "This magnificent audit of government, produced by the best talent in America, after a prodigious amount of study, is not self-enacting. To get its recommendations translated into law will require the full force of our informed, united, and sustained effort. It will take leg work, head work, and heart work."

A stimulating luncheon program developed the theme, "Keep Downtown Dynamic." Frederick J. Bashow, real estate consultant and member of the National Chamber Urban Development Team, West Palm Beach, Fla., told the group that, "The basic problem is not just parking, or density, or traffic, or obsolescence. The basic problem is our popular attitude toward city life. Revitalization of our urban centers must first take place in the minds of the people. When this happens, the physical problems will be resolved with comprehensive purpose."

Actually, Mr. Bashaw noted, there is a significant trend toward downtown living. "This trend," he emphasized, "could become electric if our people begin to reappraise the amenities of city life in terms of such vital considerations as convenience, education, and even health."

William S. Street, president and general manager of Frederick & Nelson Co., Seattle, Wash., expressed the opinion that a dynamic, successful downtown entails making the area as accessible as possible as well as the most attractive business district in the city. He quoted experts who have worked on Seattle's traffic and parking problems to prove his point that, while central business district ills are admittedly hard to cure, they will respond to remedial programs. He suggested mobilizing intelligent public opinion to aid in the solution of such problems as traffic congestion, off-street parking, mass transit, urban blight, and expressways —all potentially serious.

At another luncheon, devoted to the economic impact of the proposed national highway program, William S. Lampe, editor of the *Pittsburgh Sun-Telegraph*, discussed the many beneficiaries, direct and indirect, of such a program. Already the program has spurred research into many phases of the highway industry, he pointed out. "The latest tools of science are being studied to determine how they can be applied to the highway field. Before we are done," he predicted, "we will see a transformed industry—much more efficient, more mechanized, and one that may make the estimated cost of the whole program lower than we can believe."

Defense Department Completes Huge Records Center

Dedication ceremonies for the Department of Defense's new $15,000,000 Military Personnel Records Center in St. Louis took place on April 17. One of the twenty largest buildings in the world, the six-story reinforced concrete structure contains 1,240,000 sq ft of floor space. Special features include a mechanical mail conveyor system connecting all floors with the central mail room; a flexible lighting system, which will permit changing the illumination as required; and a special window-washing rig with an electrically operated cage that travels on rails around the building. Operating under the U. S. Army Adjutant General, the center will service and safeguard some 35,000,000 records of Army, Navy, and Air Force veterans. Construction of the enormous project started in October 1953, with award of $12,555,758 Corps of Engineers contract to Fruin-Colnon Contracting Co., of St. Louis, and Peter Kiewit Sons, of Omaha, joint venturers. W. C. E. Becker, M. ASCE, was the structural engineer, and John D. Falvey, the mechanical and electrical engineer.

Europe to Build More Expressways

New expressways are on the agenda in both France and Switzerland. In France, where highway traffic has doubled in the past five years, a billion-dollar expressway program is getting under way. Switzerland, too, is developing plans for an east-west superhighway that will cost an estimated $350 million. These plans are reported by the International Road Federation in a recent issue of its *World Highways*.

The first stage of the French program comprises a 1,244-mile network, with major routes between Paris and Marseille; Paris and Belgium (connecting with the Belgian expressway net); and Paris and the Normandy coast. Bypasses will take traffic around all the large cities involved in the network. An expressway section between Frejus and Nice, which will be built as a pilot project, is scheduled for completion by 1960. The cost of this initial stretch will be about $28 million.

The Swiss expressway will extend from Geneva at the French border to St. Margrethen, on the Austrian border south of Lake Constance. Two projected north-south links will connect Basel and Zurich with Lucerne. Later these routes will be continued over the St. Gothard Mountain south to Italy.

Ford Company to Have New Los Angeles Plant

Ford Motor Company executives recently broke ground in Los Angeles for a new multi-million-dollar plant for the company's Mercury Division. Located at Rosemead and Washington Boulevards, 14 miles from downtown Los Angeles, the project will replace the Mercury Division's present Maywood plant, which was opened eight years ago. It is being constructed on a 200-acre site with more than 30 acres of building floor area. The new steel and concrete plant will have an annual capacity of 175,000 cars in contrast to the 70,000-car capacity of the present plant. Production at the plant is scheduled to start in June 1957.

The architect-engineer is Smith, Hinchman & Grylls, Detroit, and the contractor J. H. Pomeroy & Co., San Francisco.

Installing 36-in. tar-enameled steel pipe in a wooded area northwest of Worcester.

20,000-ft steel main installed in Worcester

One of the biggest water-supply projects to be completed in New England in 1955 was the Worcester, Mass., high-pressure line. The design working pressures are 160 psi for the 36-in. ID section and 190 psi for the 30-in. ID section.

The steel main extends somewhat over 20,000 ft from the pumping station at Holden Reservoir No. 2 to a point near Indian Lake, where it connects with Indian Hill Reservoir. Its high capacity and great reserve strength make the line an important source of water for the present and future needs of industrial Worcester.

Photographed on the job are (left to right) Fred Dodge, inspector for Metcalf & Eddy, Boston, design engineers for the project; Cliff Johnson, president of Johnson Brothers, general contractor: Joseph Flatley, inspector for Metcalf & Eddy; C. B. Hardy, Water Superintendent for the City of Worcester; Ernest Johnson, partner in Johnson Brothers.

The line is 36 in. ID for some 14,300 ft from the pumping station to Grove Street, where it is reduced to 30 in. ID. Bethlehem supplied the pipe in easy-to-install 40-ft lengths, coated and lined with coal-tar enamel, and protected with felt and paper wrappings. Every length was hydrostatically tested in our shop in accordance with AWWA specifications. Field joints were made with Dresser couplings.

If you have a new large-diameter line in mind, we urge you to consider the many advantages of welded steel pipe. No other material can match steel pipe for strength, long life, resistance to damage, leak-proof joints and ease of installation. May we give you more information? Please contact the Bethlehem sales office nearest you.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

President Eisenhower Made Honorary Member of ASME

Joseph W. Barker, M. ASCE and president of American Society of Mechanical Engineers, presents certificate of honorary membership in ASME to President Eisenhower, first president of the United States to be so honored while in office. In a White House ceremony, Dr. Barker said the honor was "for acknowledged professional eminence in engineering." President Eisenhower was cited as "Soldier, statesman and President; tactful and inspiring leader whose planning and administration contributed greatly to the winning of World War II and to the defense of the free world."

GM Research Center—Where Today Meets Tomorrow

The vital cause of technical research received a tremendous boost on May 16, when General Motors dedicated its new $100,000,000 Technical Center in ceremonies viewed by thousands—at both the plant site on the outskirts of Detroit and in special television luncheon programs arranged for company executives and other interested persons all over the country. The culmination of a building program begun in 1949, the huge new center consists of twenty-five buildings dedicated to various phases of research, engineering, styling, and development. The buildings are grouped about a lake on a 330-acre tract at Warren, Mich.

A battery of distinguished speakers on the dedication program was headed by President Eisenhower, who spoke on a closed-circuit television network from Washington to 61 cities having concomitant celebrations. The President described the center as a place for leadership in furthering new attacks on technological frontiers.

"An intellectual golf course," is how ASCE Honorary Member Charles F. Kettering described the development. A pioneer in General Motors research work, Dr. Kettering serves the organization today as director and research consultant. "Here in this institution," he went on to say, "we have the place where we can make indefinite shots, and the only time we don't want to fail is the last time we try it."

Lawrence R. Hafstad, director of the General Motors research staff of almost 5,000 engineers, scientists, and technicians, called the technical center "a symbol of faith in the future and of confidence in our social system . . . . a home for the inquiring mind." Perhaps it was Dr. Hafstad who best brought home the importance of such research centers when he said, "Our choice is brutally clear. As a society, we can either learn mathematics and science—or Russian." Dr. Hafstad is a former director of the AEC's Division of Reactor Development.

General Motors President Harlow Curtice also warned the nation that its survival may depend on "more emphasis on basic research." He said that stepped-up technological progress is essential to the continuance "not only of American leadership in the free world, but of the democratic processes themselves. Today we are being put to a competitive test—a struggle for survival," he said. "We are being challenged in this one area of technological progress that we have come to regard as the source of our greatest strength."

ASEE Study Affirms Value of Liberal Education

Is liberal education, in the broad sense, out of reach of today's engineering student, whose career demands rigorous specialization but whose position may involve tremendous social responsibility? This is the question to which the American Society for Engineering Education has been seeking the answer in an intensive three-year study made possible by a grant from the Carnegie Corporation of New York. To prepare its recommendations, the survey committee polled the country's leading engineering schools and sent out teams of interviewers to study in detail how engineering students learn the humanities and how they react to them. The results of the study have just been released by the ASEE.

The answer to the question is, "No," according to the special committee, which goes on to say that, in the opinion of both engineering school teachers and leading industrial representatives, "the humanities and social sciences are, in a deeply serious sense, practical and useful." These studies need not be superficial studies, and they need not jeopardize students' technical accomplishments, says the ASEE.

"To meet his growing responsibilities and to realize his capacities as a human being, the engineer needs both professional competence and a broad understanding of himself and of the world in which he lives," the committee's report notes. "He needs depth, flexibility, and a capacity for growth in directions which we ourselves can only dimly visualize.... Given this view of the engineer as a professional man and as a human being, the humanities and social sciences can take their place as an integral part of his total education. They do not stand apart from the rest of the curriculum."

The report affirms an earlier recommendation of the ASEE to the effect that engineering students should spend at least one-fifth of their time studying the humanities and social sciences. "Our evidence," says the survey committee, "indicates that a majority of schools do not measure up to this standard; the national average is something less than 17 percent."

Semi-professional courses—such subjects as accounting, report writing, and engineering history—are called "surface skills" and are not what the committee has in mind. Courses in the humanities, it says, "should deal with subjects which, like science itself, are basic aspects of human activity in which depth of understanding provides the only sound foundation for the student's further growth."

Edwin S. Burdell, president of Cooper Union, was chairman of the special survey committee. The survey project was directed by George A. Gullette, head of the Department of Social Studies at North Carolina State College.

N. J. Turnpike Sets New Traffic and Safety Records

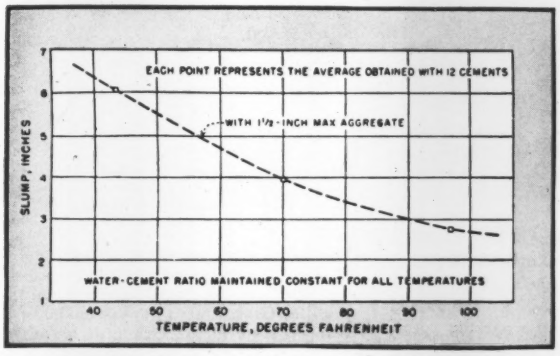
New records in traffic and revenue were piled up in 1955 by the New Jersey Turnpike, which also had an outstanding safety record. The annual report of the commissioners of the Turnpike Authority show that a total of 25,888,391 revenue vehicles used the 118-mile superhighway in 1955, an increase of 5.43 percent over 1954 and a volume well in excess of engineers' estimates. Revenues from tolls and concessions amounted to $23,905,624 compared to $23,217,762 in the previous year.

There were 675 accidents (with 26 fatalities) on the turnpike in 1955, equal to a rate of 71.6 for each 100 million miles of vehicle travel. This rate was about one-sixth that for New Jersey's public highways and a mere fraction of the rate for the nation's highways as a whole. The fatality rate of 2.76 per 100 million miles compared with an estimated 6.5 rate for the nation as a whole.

Why Should HOT WEATHER CONCRETE Concern You?

... because HOT WEATHER CONCRETE sets more quickly, has lower ultimate strength, cracks more, and requires more mixing water than concrete made at cooler temperatures. In addition to structural deficiencies, HOT WEATHER poses problems with placing, compacting, and finishing.

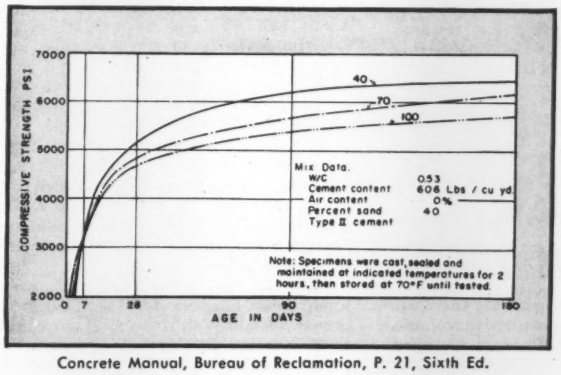
LOSS IN SLUMP



Concrete Manual, Bureau of Reclamation, P. 6, Sixth Ed.

This graph illustrates the loss in slump due to hot weather. Notice the 4" loss between 40°F and 100°F. Normally this loss in slump is overcome by adding more water to the mix. The result – more cracking and lower ultimate strength.

LOSS IN STRENGTH



Concrete Manual, Bureau of Reclamation, P. 21, Sixth Ed.

Even when no extra water is added to concrete in hot weather, strength will go down. Notice the 800 psi loss in strength at ninety days between concrete at 40°F and 100°F.

WHY TEMPERATURE AFFECTS CONCRETE – A cement gel forms around each grain of cement in the initial stage of mixing. The gel is large in hot weather and relatively small in cold weather. A large gel requires more water. Thus, the gel size governs the water requirement and ultimate quality. Gel size can be controlled ... physically, by cooling the mix with ice ... chemically, by controlling the mix with an exclusive gel-reducing agent ... PLASTIMENT.

RETARDED SET – When the cement gel is reduced in size chemically, the setting time will be retarded in proportion to the quantity of Plastiment which is added. Thus a simple specification based on temperature and varying quantities of Plastiment will provide for uniform setting time and water requirement at all job temperatures. This chemical control will result in the high ultimate strength and reduced cracking that is obtained with cooled concrete.

BLEEDING ACTION – With the chemically controlled cement gel there is a unique type of bleeding action. Field men will notice a rapid release of clean, clear mixing water without scum or laitance after the concrete has been placed. In a wet mix this effect is very noticeable and serves as a "safety valve" by releasing the excess water and thus lowering the water cement ratio of the concrete in place.

PLASTIMENT ACTION – Plastiment's action is uniform and predictable. It may be added as a powder or liquid to an established mix or included in the original mix design. It does not entrain air and so may be added in variable quantities to suit the job conditions. Plastiment works only on the cement gel and therefore may be used in any type of plain or air entrained concrete.

CONCLUSION

Hot weather concrete can be controlled chemically to give uniform high quality and normal setting time through the use of varying proportions of Plastiment. Write today for Sika's *all-temperature concrete specification.*

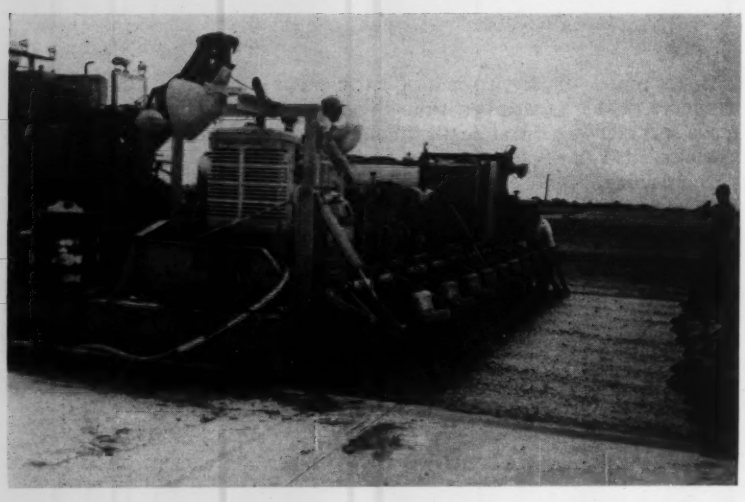
Sika

PLASTIMENT CONCRETE DENSIFIER

SIKA Chemical Corporation, Passaic, New Jersey

DISTRICT OFFICES: BOSTON • CHICAGO • DALLAS • PHILADELPHIA • PITTSBURGH • SALT LAKE CITY • WASHINGTON, D. C.
MONTREAL, CANADA • VANCOUVER, CANADA • PANAMA CITY, PANAMA • DEALERS IN PRINCIPAL CITIES

New Touchdown Strip for Portsmouth Air Force Base



Here ten Viber electric vibrators are used to vibrate concrete to a depth of 20 in. on 1,000-ft touchdown strip of new Portsmouth (N.H.) Air Force Base. Morrison-Knudsen Co., Inc., and Landers & Griffin, Inc., of Portsmouth, have two prime contracts, totaling $17,000,000 to build 11,620-ft runway designed to take the weight of giant Army B-52's. Job entails moving 5,788,000 cu yd of earth excavation and borrow, and building a parking apron 8,500 ft long and 1,010 ft wide. About 423,000 cu yd. of concrete will be needed for the job, which will be completed this fall. Photo courtesy International Harvester Co.

Record Steel Shipments Reported for March

A larger tonnage of finished steel products was shipped from the steel mills of the country in March than in any previous month in history, according to the American Iron and Steel Institute. The record total of 8,255,824 net tons exceeded by more than 485,000 tons the total for the previous record month of June 1955, when the total was 7,770,213 tons.

Market categories receiving the record tonnages include warehouses and distributors (1,562,726 net tons); construction, including maintenance (947,576 net tons); contractors' products (401,383 net tons); and machinery, industrial equipment and tools (485,497 net tons).

Research Manager for ASME

John Thomas Reid, mechanical engineer and business administrator, has been named research manager of the American Society of Mechanical Engineers. For the past five years Mr. Reid has been with the Westinghouse Electric Corp., at its Newark, N.J., plant. An alumnus of the Massachusetts Institute of Technology, Mr. Reid also holds graduate degrees from the University of Minnesota and Rutgers University.

His duties with the ASME will include staff service for the organization's various research committees, coordination and assistance in fund-raising for research projects, and liaison with Engineering Foundation and the National Research Council.

AGC Predicts Upswing In Construction Activity

Recent developments indicate there will be a marked rise in construction volume, according to Frank J. Rooney, president of the Associated General Contractors of America. In contrast to the first four months of 1956 when the volume of new construction put in place barely equaled the record total of $11.8 billion performed during the same period of 1955, the coming months should see a rise toward the all-time high of $44.5 billion forecast by the AGC last January, Mr. Rooney stated. Last year the total volume of new construction was $42.5 billion.

Mr. Rooney bases his predictions on expectation of "a continuation of the current unprecedented levels of non-residential construction, coupled with recovery in residential activity." Private commercial and industrial building are now running ahead of even the most optimistic forecast for these categories, he noted. "In the first quarter of the year contract awards for future construction set an all-time record, which will be translated into a substantially increased volume of construction for the balance of the year." Mr. Rooney sees the proposed national highway program as a key feature in the anticipated upswing.

On the basis of contractors' reports from various parts of the country, delay in deliveries of materials is seen as one factor that could hamper the industry in setting a new record.

State Programs Speed U.S. Topographic Mapping

Kentucky is currently completing a $6,360,000 cooperative mapping program with the U. S. Geological Survey that gives the Blue Grass State top rank as the best-mapped state in the Union, according to Acting Secretary of the Interior Clarence A. Davis. The new maps—to a scale of 1:24,000 or 2,000 ft to the inch—cover the entire state.

Although twelve other states also have complete map coverage, only three of them—Massachusetts, Rhode Island, and Connecticut—can be compared with Kentucky's 100 percent top-grade mapping. The country as a whole has less than 40 percent coverage at the standard scales of 1:62,500 and 1:24,000. At present the Survey has about 18,000 published maps in the National Topographic Series. About half of them are 1:24,000-scale, and the majority of the remainder are 1:62,500-scale publications.

Cooperative agreements between the states and the Geological Survey for mapping date back to 1884, when the first program of the kind was authorized by Congress. In that year Massachusetts began a long-range program, which resulted eventually in the complete topographic mapping of the state. Kentucky began its program in 1904 with an appropriation of $5,500.

According to Gerald FitzGerald, chief topographic engineer for the Geological Survey, World War II demonstrated that maps are critically needed, and that the pre-war production rate of 100 a year was woefully inadequate. With new precision techniques and increased funds, he said, it has been possible to step up the rate of new mapping from about 12,000 sq miles in 1943 to about 133,000 sq miles in 1955. Nevertheless, there are still vast unmapped areas in the United States, whose full potential usefulness is still unknown. Mapping requested by the Department of Defense will cover nearly 1,000,000 sq miles and will not be completed until 1962.

MULTI-PURPOSE
SEMI-PORTABLE
STANDARDIZED
INTERCHANGEABLE

FORM-CRETE

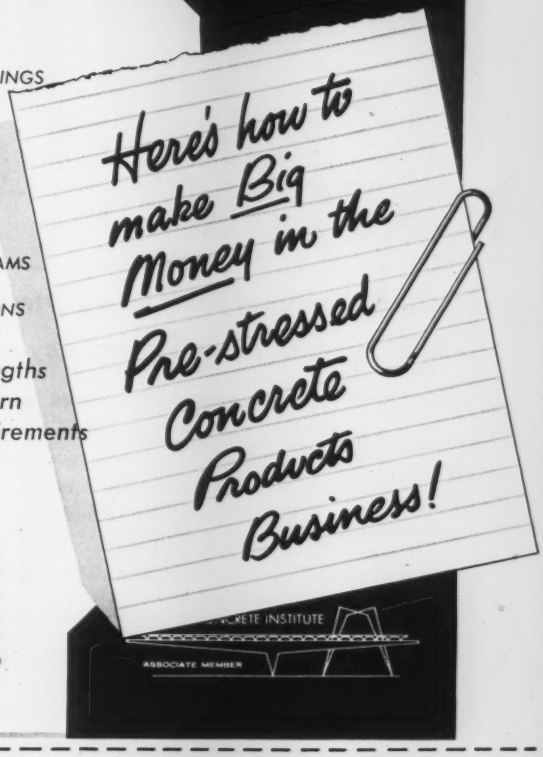
TRADE MARK

STEEL FORMS

for PRECASTING REINFORCED OR PRESTRESSED CONCRETE

★ SQUARE AND OCTAGONAL PILINGS
★ SOLID AND HOLLOW LINTELS
★ SINGLE T JOISTS
★ DOUBLE T SLABS
★ STATE ROAD TYPE BRIDGE I BEAMS
★ PAN TYPE BRIDGE DECK SECTIONS

...in all practical sizes, lengths and gauges to meet modern concrete construction requirements



DESIGNED, ENGINEERED AND MANUFACTURED BY

FLORIDA DIVISION
FOOD MACHINERY
AND CHEMICAL CORPORATION
LAKELAND, FLORIDA

fmc
FOOD MACHINERY AND CHEMICAL CORPORATION

Get in on the Ground Floor - Mail this Coupon Now!

FOOD MACHINERY AND CHEMICAL CORPORATION, FLORIDA DIVISION, P. O. BOX 1718, LAKELAND, FLORIDA

FREE FORM-CRETE BULLETIN 100

Company Name_____

Your Name and Title_____ St. & No._____

City_____ Zone_____ State_____ PF-3

New Optical Plummet Built into Gurley Transit Saves Set-up Time, Improves Accuracy on Windy Days

Years ago, Gurley introduced lightweight instruments to combat wind vibrations. Now Gurley further beats the wind problem with an optical plummet *built into* the instrument.

The new Gurley Optical Plummet Transit eliminates swing and sway of the cord and plumb—always time-consuming and exasperating on a windy location, and inaccurate as well. Positive accuracy of set-up is assured with the Gurley Optical Plummet.

The new Gurley transit is furnished with a tripod with built-in shifting head, and allows a two-inch shift of the instrument over the point. This provides greater latitude in initial set-up.

Gurley's new Optical Plummet Transit offers one of the advantages of the optical-reading theodolite *plus* the desirable features of simplicity and universal acceptance of the American transit. For further details, write for Bulletin OP-57.

GURLEY

W. & L. E. GURLEY 518 Fulton Street, Troy, New York

Gurley—Since 1845

N. G. Neare's COLUMN

R. ROBINSON ROWE, M. ASCE

KNXVL 10 NITE JUN 1 220AM
SAUER DOE ENGRS CLUB
ESSEYEVILLE USA

WILL MISS JUNE MEETING AC KNOXVILLE CONVENTION STOP CARRY ON AS GUEST PROFESSOR UNBOOZLING YOUR BAMBOOZLER ABOUT SCRAMBLE TRAFFIC IN ESSEYEVILLE STOP TRY JOE KERR FIRST THEN CAL KLATER STOP READ THIS NEW PROBLEM COLON SPACE TOURISTS JUST RETURNED FROM JUPITER REPORT NOVEL USE OF MOONS BY JOVIAN SURVEYORS TO RECKON HEIGHT OF OBELISK KNOWN AS IO'S NEEDLE STOP ONE NITE WITH TWO BRIGHT MOONS NEEDLE'S SHADOWS TO WEST MEASURED 66 AND 114 JOVOMETERS LONG AND SEVERAL HORAS LATER THEY WERE 55 AND 99 JOVOMETERS LONG TO THE EAST STOP ASK HOW HIGH IS IO UNCOLON BIG CROWD HERE STOP WEATHER HOT AND STICKY STOP HOPING YOU ARE THE THE SAME N G NEARE

"So," said the Guest Professor after reading the telegram, "here I am, ready to follow orders. My bamboozler, as Professor Neare called it, was the calculation of the percentage of diagonal traffic at a local intersection using the scramble system. For the purpose, the city was idealized as an infinite grid, with all intersections scrambled, and with pedestrian trips classified as $1/2$ to the next block, $1/4$ to the second block, $1/8$ to the third, and so on. As ordered, I'm calling on Joe Kerr first."

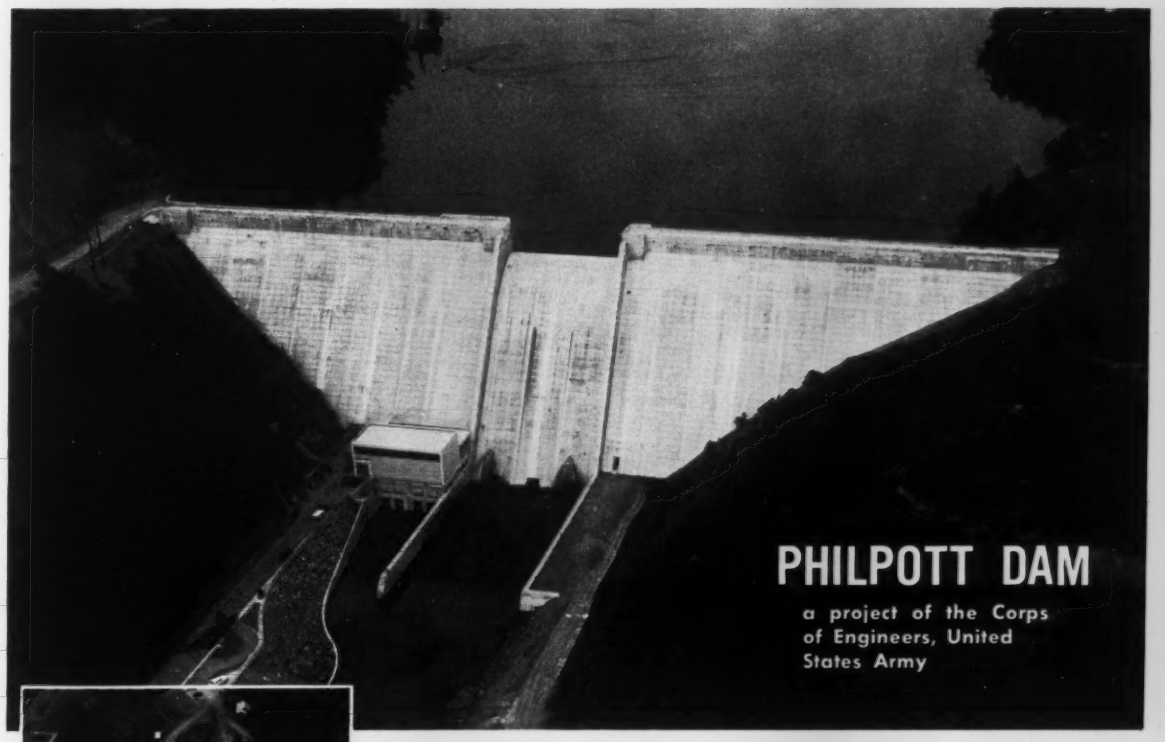
"Not here," cried the Secretary. "Gone to the Local Section Conference at Knoxville."

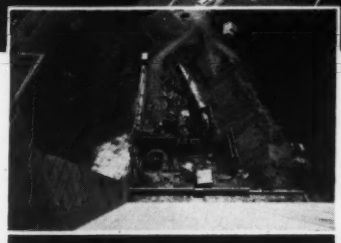
"Then Cal Klater."

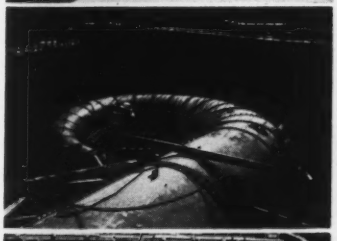
"Gone to Knoxville, too, to read a paper in a dam symposium."

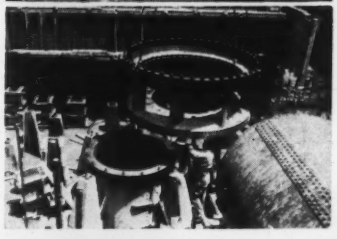
"Looks like a break for me," shouted Ken Bridgewater. "I always work the problem and never have a chance to talk. I reasoned first that, in your idealized boundless city, the chance of a pedestrian scrambling diagonally was independent of his origin, so I analyzed all traffic starting from the south frontage of Block 00 (Fig. 1). The four sides of any other block involve the same combination of

(*Continued on page 94*)









Another Outstanding Installation of **Leffel Hydraulic Turbines**

Philpott Dam, a new Corps of Engineers, United States Army, project on the Smith River in Henry and Franklin Counties, Virginia, is the site of another outstanding installation of efficient, reliable Leffel turbines. The Philpott project was constructed for flood control, hydroelectric power generation and allied purposes. It is one unit of a comprehensive reservoir system planned for the Roanoke River basin.

Three Leffel turbines were installed in the Philpott power plant. Two are rated at 9400 H.P., 277 R.P.M. at 152 ft. net head and the third at 860 H.P., 720 R.P.M. The view above shows the completed project. The views at left show the powerhouse under construction with the spiral casing for one turbine in place, a close-up of the assembled spiral casing, and the stay ring being lowered into place over the draft tube.

Other Leffel installations are dependably and efficiently producing power from water in all parts of the world. Leffel engineers are waiting to put their 94 years of experience with water power to work for you, whether your project is a completely new installation or expansion or rehabilitation of existing facilities. Write today for literature describing Leffel turbines for all hydraulic power requirements and showing a wide variety of outstanding Leffel installations.

1095-E

FOUNDED IN 1862

THE JAMES LEFFEL & CO.

DEPARTMENT C • SPRINGFIELD, OHIO, U. S. A.

MORE EFFICIENT HYDRAULIC POWER FOR 94 YEARS

Yuba designed this screen for long life, minimum maintenance. Inner and outer screens easily renewed. Can be lubricated from outside.

HEAVY-DUTY SCREENS MADE TO FIT YOUR NEEDS

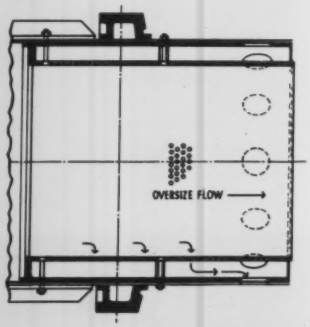
Flat or revolving • long-wearing non-clogging • competitively priced

—order from YUBA

For example – this double-jacketed screen, 35′ long and 8′ in diameter, washes and screens three sizes of sand simultaneously. Yuba-built screen plates are made from Abrasion Resisting Steel plates with a hardness ranging up to 250 Brinnell. This is a high carbon, high manganese alloy steel produced especially for screening purposes. In many places, screens of this tough, abrasion resisting steel last twice as long as ordinary screens. Naturally, this reduces downtime and replacement costs.

Yuba taper-drills screen holes to prevent clogging (unless you request straight sides). Holes can be as small as 3/16″ diameter; closely spaced for screening monazite sands and other rare earths. Thicknesses from 3/16″; length, diameter and other dimensions to suit your needs. Yuba screen plates are rolled true and cut square to close limits – insuring proper fit and fast installation.

Yuba stocks abrasion resisting steel in many thicknesses, usually can make prompt delivery. Try long-wearing, non-clogging Yuba screens now. For estimates, send screen details, hole sizes and spacing. No obligation. Wire, write or phone TODAY.



Yuba-built Olsen trommel increases screen capacity as much as 25%, by converting lower end blank shell plates into screening area . . . does not increase screen length.

102

YUBA DREDGES — PROVED DEPENDABILITY AROUND THE WORLD

YUBA MANUFACTURING CO.

Room 605, 351 California St., San Francisco 4, California, U. S. A.

AGENTS { SIME, DARBY & CO., LTD. • SINGAPORE, KUALA LUMPUR, PENANG. SHAW DARBY & CO., LTD., 14 & 19 LEADENHALL ST., LONDON, E. C. 3.

CABLES: YUBAMAN, SAN FRANCISCO • SHAWDARBCO, LONDON

N. G. Neare's Column

(*Continued from page 92*)

street crossings, so I marked each surrounding block with a 2-digit number, the tens digit being the number of parallel crossings and the units digit the number of diagonal crossings.

"Now there is a $^1/_8$th chance that pedestrians will take a 3-block walk, for example, terminating in one of the 48 block frontages marked by the crazy-quilt pattern. Counting the crossing symbols, I computed 36 chances in 106 of each crossing being diagonal, as follows:

12	02	11	20	11	02	12
21	11	01	10	01	11	21
30	20	10	00	10	20	30
21	11	01	10	01	11	21
12	02	11	20	11	02	12
03	12	21	30	21	12	03

Fig. 1. Locus of 3-block destination from central origin rivals grandmother's crazy quilt.

Symbol	Blocks	Parallel	Diagonal
01	4	0	4
02	4	0	8
10	1	1	0
11	16	16	16
20	8	16	0
21	8	16	8
30	7	21	0
Totals	48	70	36

"Deriving similar chances for shorter and longer trips, I found the answer by summing the series:

$$P = {}^1/_2 \cdot \frac{4}{10} + {}^1/_4 \cdot \frac{16}{46} + \frac{1}{8} \cdot \frac{36}{106} \cdots = 0.37$$

"Good," applauded Professor Doe, "but the patterns can be formulated so as to express your series

$$P = \sum \frac{1}{2^n} \cdot \frac{4n^2}{12n^2 - 2} = \frac{1}{3}\left(1 + \sum_1^\infty \frac{2^{-n}}{6n^2 - 1}\right) = 0.3714$$

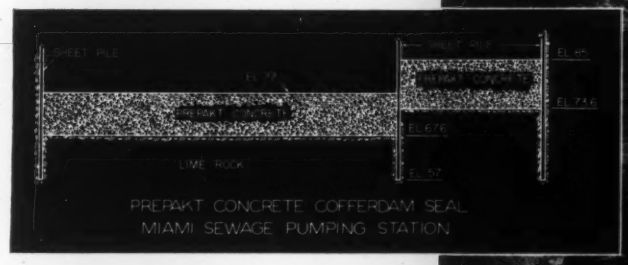
With 4 parallel and 2 diagonal lanes, traffic is 18 percent heavier along the diagonals. Thanks, Ken, and don't forget the new problem in the telegram."

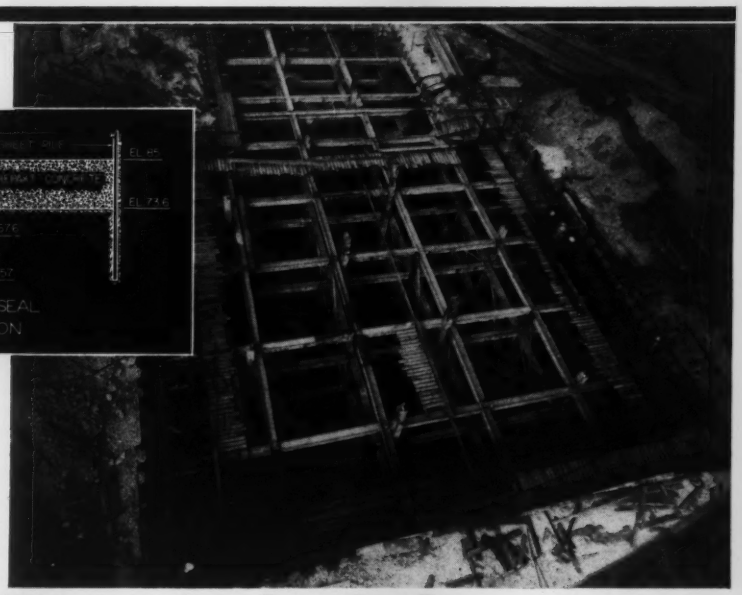
[*Ken Bridgewater was Thatchrite (Guy C. Thatcher), and the Guest Professor was Marvin Larson.*]

Owner: City of Miami, Florida
Engineers: Connell & Rader Associates, Miami
Contractor: DeFonce Construction Co., Inc.

EXCAVATION FULL OF WATER **was situation met by INTRUSION-PREPAKT. This was the best that usual dewatering methods could do.**

Conventional dewatering methods failed





DRY COFFERDAM **was produced by underwater placement of PREPAKT concrete cofferdam seal, later used as base for the structural slab of the building.**

but Intrusion-Prepakt had the answer

INTRUSION-PREPAKT solved a difficult dewatering problem at the N. E. 9th St. Sewage Pumping Station, Miami, Florida. A close-to-the-surface water table plus a porous lime rock substrata produced a water flow that the contractor could not lick with usual methods.

A PREPAKT concrete cofferdam seal, placed underwater directly on rock, provided a water-tight joint and a tight structural tie-in with the sheet piling. This halted water leakage and resulted in a dry cofferdam.

PREPAKT concrete is made by consolidating preplaced aggregate with INTRUSION mortar—a method which eliminates dilution and other weaknesses to give a strong, monolithic structure. On this job, the PREPAKT seal withstands a 36-foot hydrostatic head. Made underwater or in the dry, PREPAKT concrete is of superior quality, has virtually no shrinkage, embeds reinforcing thoroughly and seals without need for after-grouting.

To save time and money on your next difficult foundation or structural concrete problem, contact: INTRUSION-PREPAKT, Inc., Room 779-N, Union Commerce Bldg., Cleveland 14, Ohio. In Canada: INTRUSION-PREPAKT, Ltd., 159 Bay St., Toronto, Ontario.

INTRUSION-PREPAKT, INC.

OFFICES IN PRINCIPAL U. S. AND FOREIGN CITIES

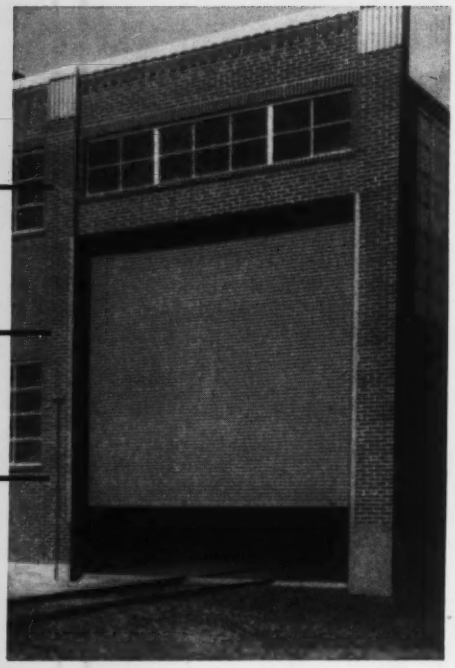
Intrusion and Prepakt are trade marks of Intrusion-Prepakt, Inc., whose methods and materials are covered by U. S. Patents Nos. 2313110, 2655004, 2434302 and others, also patents pending.

Doors open straight upward--no space is wasted anywhere

Maximum protection against theft, riot intrusion, vandalism

Every door is REGISTERED[1] for your protection

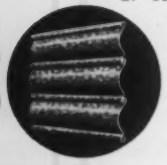
Extra-heavy zinc coating, for lasting weather resistance[2]

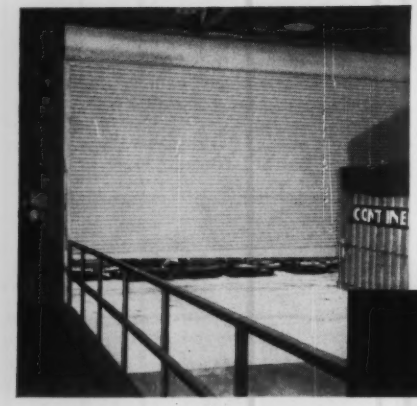


Kinnear Rolling Doors

You get *more* protection plus *more* efficiency in Kinnear Rolling Doors. Coiling above the doorway, they open out of the way! They never block light from close-by windows or fixtures. No floor, wall, or ceiling space is sacrificed. Hoists, conveyors, high-lift fork trucks and similar equipment can be used to maximum advantage.

1. Details on every Kinnear door are REGISTERED—kept in fire-safe vaults. Damaged or worn parts are *permanently* replaceable. Your Kinnear Door is never "orphaned."
2. Kinnear's rugged interlocking-slat curtain is heavily galvanized (1.25 ounces of pure zinc per sq. ft., A.S.T.M. Standards). In addition, the special Kinnear Paint Bond assures immediate, thorough coverage and adhesion of field-applied paint.





Kinnear Rolling Doors are engineered to fit any need, with manual-lift, crank, chain or electrical operation. Controls for motorized doors can be placed at any number of convenient spots. For long, low-cost service, insist on Kinnear Rolling Doors! *Write for catalog.*

The KINNEAR Mfg. Co.
FACTORIES
1500-20 Fields Ave., Columbus 16, Ohio
1742 Yosemite Ave., San Francisco 24, Calif.

KINNEAR
ROLLING DOORS
Saving Ways in Doorways

News of Engineers

(*Continued from page 28*)

Garth A. Fuquay, employed by the Corps of Engineers for the past fifteen years, recently as chief of the Soils Section, South Pacific Division, has accepted employment as chief soils engineer in the Bangkok, Thailand, office of Tippetts, Abbett, McCarthy, Stratton of Panama, Inc. His address will be c/o Chief, Navy Section, JUSMAG, Box B, APO 74, San Francisco, Calif.

William J. Hess, chief building inspector for Sacramento County, became resident engineer for the American Iron and Steel Institute, with headquarters in Los Angeles, on May 7. Mr. Hess was the first chief building inspector for the county, and was instrumental in developing building, plumbing and electrical codes for its unincorporated areas. In his new position he will be in charge of the committee on building codes on the Pacific Coast.

Maxwell M. Upson, chairman of the board, Raymond Concrete Pile Company, New York, was honored by 300 of his fellow workers recently with a dinner at the Waldorf-Astoria, in recognition of his eightieth birthday. He received a bronze plaque commemorating the event and honoring him as a constructor, engineer and inventor. He has been with the Raymond Company for 49 years.

M. M. Upson

Newman E. Argraves, Connecticut State Highway commissioner, was cited by the Connecticut Society of Professional Engineers as the state's "Engineer of the Year" at a recent dinner. Mr. Argraves was appointed state highway commissioner in March 1955.

Joseph D. Sage was recently appointed research assistant in civil engineering at Rutgers University. He was formerly an engineer with Cities Service Oil Co., and has been serving as an installation engineer with the Air Force.

Bobby R. Cooke, a 1953 Texas Tech graduate, has been awarded a Rotary Foundation Fellowship to study abroad next year and has made tentative plans to study at the University of Birmingham, England. He is now doing graduate work at the University of Texas following a tour of duty with the Army.

Gilbert Mading Dorland, Colonel, U. S. Army and district engineer at Nashville, Tenn., is retiring from the Army and will join the Nashville Bridge Company in July as assistant to the president at Nashville. Colonel Dorland has been district engineer at Nashville since 1952.

(*Continued on page 98*)

Always Ahead...

LONG LENGTH concrete pipe

with RUBBER and STEEL **AMSEAL JOINTS**

These long lengths are always ahead of the job—because American-Marietta Company's many up-to-date facilities, strategically located throughout the country, assure prompt and regular deliveries. Long lengths speed installation, too, by reducing handling and joint making. Built-in smoothness of *unquestioned permanence* provides sustained high flow capacity—cuts operation and maintenance costs.

"Pressure proven" rubber and steel AMSEAL Joints are flexible to permit normal expansion, contraction, deflection and settlement—yet they provide a positive, water-tight seal against costly infiltration or leakage.

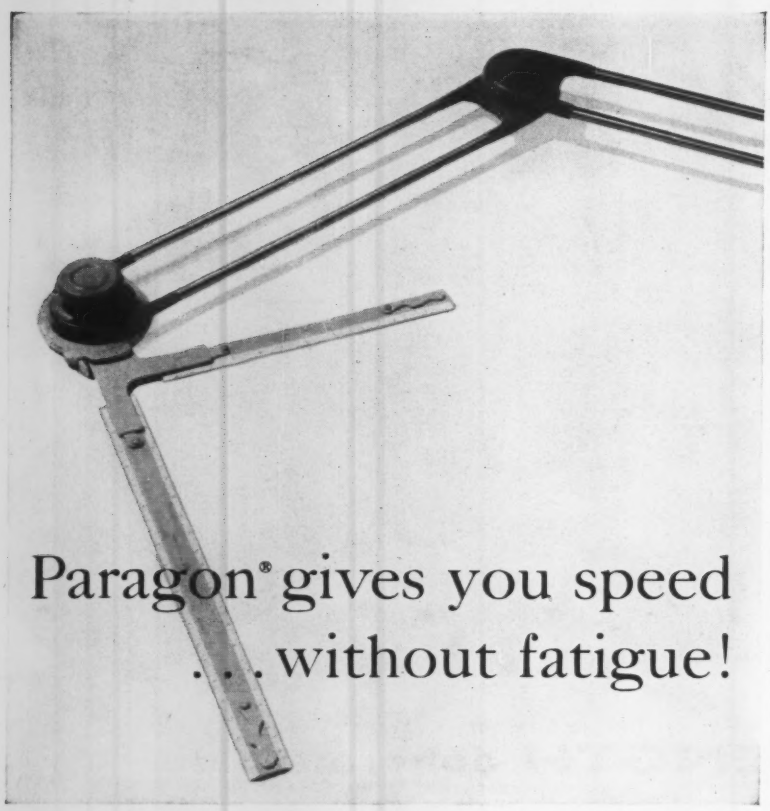
Be sure to specify long length concrete pipe with AMSEAL Joints for water intakes, sewage outfalls, inverted siphons, intercepting sewers, circulating systems and low pressure sewer and water mains.

Our technical staff will be pleased to assist you with your pipe problems.

AMERICAN-MARIETTA COMPANY
CONCRETE PRODUCTS DIVISION
GENERAL OFFICES:
AMERICAN-MARIETTA BUILDING,
101 EAST ONTARIO STREET, CHICAGO 11, ILLINOIS PHONE: WHITEHALL 4-5600

DIVISIONS AND SUBSIDIARIES

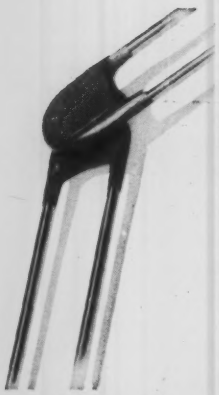
B. C. Concrete Company, Ltd. — Concrete Products Co. of America — Lewistown Pipe Company
Concrete Conduit Company — Lamar Pipe and Tile Company — Universal Concrete Pipe Co.
Tellyer Concrete Pipe Co. — American-Marietta Company of Pennsylvania



Check the response-to-the-touch. You can actually feel the difference!

That's why the Paragon Drafting Machine noticeably cuts end-of-the-day fatigue . . . saves costly man hours . . . helps raise working standards.

See how easily protractor control ring can be reached—no matter what position your hand is in. Another time saver. Touch that ring with your *little* finger and scales rotate freely. Release pressure and scales automatically lock to nearest 15° position. And intermediate angles are just as easily set!



Top day-to-day performance is guaranteed by unique "open center" design of arms which protects smooth-working factory-set band tension.

A good look at a Paragon and a touch on that control ring is worth 1,000 words! Try it before you buy *any* drafting machine—you can *feel* the difference.

89 YEARS OF LEADERSHIP

In equipment and materials for drafting, surveying, reproduction and optical tooling . . . in slide rules and measuring tapes.

KEUFFEL & ESSER CO.

NEW YORK • HOBOKEN, N. J. • Detroit • Chicago • St. Louis • Dallas • San Francisco • Los Angeles • Seattle • Montreal

News of Engineers

(*Continued from page 96*)

William B. Scheckel announces the formation of a partnership with **August G. Sperl** to engage in the general practice of consulting engineering under the firm name of Sperl-Scheckel Associates with offices at 441 Lexington Avenue, New York 17, N.Y. Mr. Scheckel was formerly chief structural engineer with Voorhees, Walker, Foley & Smith.

Joseph E. English retired April 1 as city engineer of Trenton, N.J., after 45 years of service to the city. He joined the city government in 1911 and held the positions of principal assistant engineer and engineer of streets. Mr. English will work on a voluntary basis as long as he is needed and will remain an ex-officio member of the Trenton Planning Board.

Horace B. Lester, Major, U. S. Army Reserve, has been appointed commanding officer of the 343rd Engineer Construction Battalion at Jackson, Miss. Major Lester has served with the 343rd since it was originally designated an Army Reserve training unit in Jackson. He is a partner in the firm of Wade & Lester, with offices in Jackson.

Arnold W. Conti was elected vice-president of the Worcester County Institution for Savings at its 128th annual meeting held in March. Mr. Conti joined the bank in 1954 and was elected executive mortgage officer in March 1955.

Dwight A. Chase, Captain, U. S. Coast Guard, has been appointed commander, Second Coast Guard District, with headquarters in St. Louis. Connected with the Coast Guard since 1939, Captain Chase for the past two years has been chief of staff for the Second District in St. Louis.

Henry Edward Helmboldt. Colonel, Corps of Engineers, and post engineer at Fort Ord, Calif., for the past three years, has been reassigned as resident engineer at Childersburg, Ala., in the Mobile Engineer District. He will report in July.

Philip Sporn, president of the American Gas & Electric Co. and pioneer in utility engineering practice, received the honorary degree of doctor of humane letters at Marshall College graduation exercises on May 28. Mr. Sporn was featured commencement speaker.

Allen R. Bacon is now resident manager on construction of the Kaiser Aluminum & Chemical Corporation's new aluminum plants at Ravenswood, W. Va. He will supervise construction of both the sheet and foil rolling mill, now under way, and the aluminum reduction plant on which construction will start shortly. He recently served as project manager for the construction of a $31 million powerhouse on the Columbia River at The Dalles, Oregon, and for construction of Albeni Falls powerhouse, Idaho.

UNIVERSAL FORM TIES

a Complete Line From 1 Source

SPIROLOC Form Ties

SPIROLOC Cone Nut Assembly

The most positive internal spreader and form tie

**Faster Erection . . .
Positive Holding . . .
Easier Stripping**

- Greater tie strength for heavy construction
- Fewer ties per sq. ft. of form area. LOWER MATERIAL and LABOR COSTS
- Positive breakbacks
- Permanent, reuseable equipment
- RENTED . . . SOLD

Positive Spreader Ties for all types of Concrete Construction

TWISTYES

Combination wedge and bearing plate . . . easy application . . . won't twist or fall off — ample take-up.

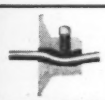
- Low cost ties for job-built or prefabricated forms
- Used with or without walers
- Accurate breakbacks . . . minimum plug required
- Choice of Spreader Washer . . . ⅞" flat is standard
- Rugged Twistye and Snap Tie Clamps have extra bearing surface . . . additional safety factor

SNAP TIES

Curved ends speed installation and stripping . . . long slope wedge for ample take-up. Extra nail holes permit nailing clamp in any position.

FORM CLAMPS

The *Most Versatile* Tie . . . At the Lowest Cost



- 2 Form clamps and a mild steel rod make a tie to handle any condition
- Wide clamp base gives more bearing on waler . . . won't "bite" at maximum loads
- Notched base permits nailing to waler

UNIVERSAL FORM CLAMP CO.

GENERAL OFFICES AND FACTORY: 1238 N. Kostner • Chicago 51, Illinois
OFFICES AND WAREHOUSES
CLEVELAND, OHIO, 24901 Lakeland Blvd. • BALTIMORE, MD., 661 S. Monroe St. • HOUSTON, TEXAS, 2314 Preston Ave. • SAN LEANDRO, CALIF., 2051-9 Williams St. • LOS ANGELES, CALIF., 5855 South Western Ave.

SERVICE WHEREVER YOU BUILD . . . COAST TO COAST

DISTRIBUTORS IN PRINCIPAL CITIES

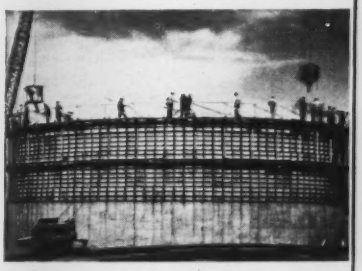
Copyright 1955-by UNIVERSAL FORM CLAMP CO., Chicago 51, Ill.

UNI-FORM Concrete Forms

3 SIMPLE ELEMENTS FORM ANY CONCRETE STRUCTURE

UNI-FORM Concrete Forms are prefabricated steel-framed, plywood faced panels . . . ready to use when they reach the job.
UNI-FORM Ties and Keys lock and spread Panels into an automatically accurate form. No measuring — no guesswork. Completely versatile . . . they form straight, battered, circular, irregular or curved walls at lowest all around cost.

Rented . . . Sold . . .
Rented With Purchase Option



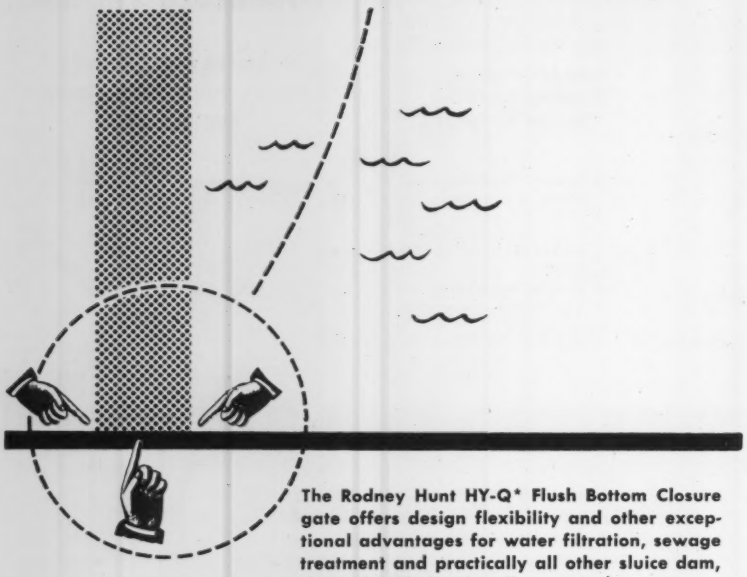
HIGH SPEED CIRCULAR WALL FORMING

UNI-FORMS provide faster, simpler and easier circular wall forming . . . one side alignment and bracing . . . absolute control of concrete, and safer, cleaner working areas.

Write for the UNI-FORM Catalog and complete details

UNIVERSAL
FORM CLAMP CO.
1238 N Kostner Ave
Chicago 51, Illinois

the HY-Q Sluice Gate seats flush on the bottom of the channel!



The Rodney Hunt HY-Q* Flush Bottom Closure gate offers design flexibility and other exceptional advantages for water filtration, sewage treatment and practically all other sluice dam, channel and chamber flow control.

1. You get maximum flow because there is minimum turbulence at the point of greatest head.
2. You get *complete* drainage naturally; no need for pumps and piping to get out water trapped behind a sill.
3. You get maximum clear opening because full flow at every raising of the gate sweeps the channel clear of silt and debris.
4. You get maximum hydraulic gradient because the HY-Q gate seats at the lowest level of the channel.

Send for a new 12-page catalog – No. 75 – giving complete description and specifications of the patented Rodney Hunt HY-Q Flush Bottom Closure Sluice Gate.

*HY-Q is a trademark of Rodney Hunt Machine Co.

RODNEY HUNT MACHINE CO.
Water Control Equipment Division
86 LAKE STREET, ORANGE, MASSACHUSETTS, U.S.A.

RODNEY HUNT

DECEASED

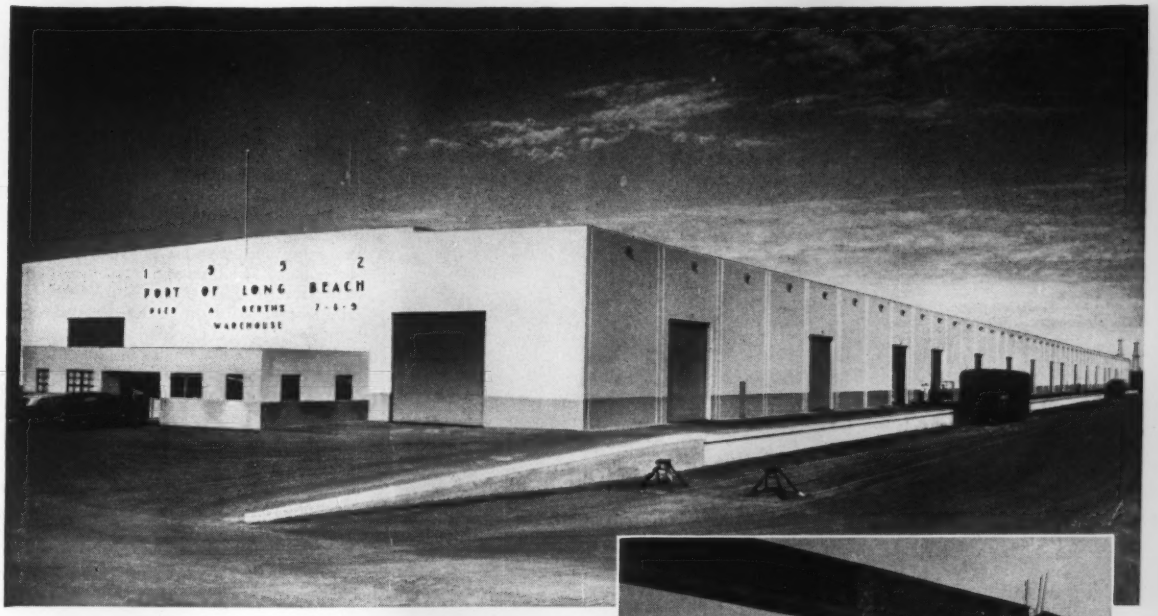
Howard Fred Bell (M.'32), age 72, civil engineer and county surveyor for Park County and Cody, Wyo., died at his home in Cody on March 23. Mr. Bell had been county surveyor for Park County for over 43 years and engineer for the Town of Cody for nearly 35 years. A graduate of Ohio State University, class of 1909, he was in private practice at Cody for 22 years. In 1933 he entered into the partnership of Bell and Donnell, practicing until recently in Hot Springs County, Worland, and Powell, Wyo. Mr. Bell had also been engineer for the Town of Powell.

Francis Blossom (M. '07), age 85, senior partner in the firm of Sanderson & Porter, engineers and constructors of New York City, died at his home there on March 12. A civil engineering graduate of Columbia University School of Mines, class of 1891, Mr. Blossom started his career with the C. W. Hunt Company, designing and building coal-handling machinery. In 1899 he joined Sanderson & Porter. He managed the engineering department for twenty years and was responsible for many power, light and traction installations. During World War I, Mr. Blossom headed a board appointed to review and report on construction work for the War Department. In 1940, Secretary of War Henry L. Stimson recalled him for similar duty. He was on the Army Construction Advisory Committee and served the Reconstruction Finance Corporation as advisory engineer of the Second Federal Reserve District. Mr. Blossom was also a director and member of the executive committee of the Federal Light and Traction Company.

James Brace (M. '04), age 85, president of Fraser-Brace Engineering Company, Ltd., of Montreal and vice-president of Fraser, Brace & Company of New York, died at his home in Westmount, Canada, on April 10. A native of New York, Mr. Brace was a civil engineering graduate of the University of Wisconsin, class of 1892. Early in his career he held various positions on the construction and design of power stations, drainage canals and waterways. In 1908 he formed a partnership with Charles E. Fraser, which became Fraser-Brace Engineering Co., Ltd., with associate companies in Canada. He supervised the construction of some of the largest chemical plants and smelters in Canada as well as pulp and paper mills in Ontario, Manitoba, and Quebec. In World War I he was a major in the Corps of Engineers, and in the recent war he was vice-president of United Shipyards Ltd., which constructed and outfitted many cargo ships.

Lester V. Branch (M. '17), age 76, prominent California civil engineer, died at his home in Beverly Hills on March 1. From 1933 to 1941 Mr. Branch was office

(*Continued on page 102*)



Precast and Prestressed Concrete Reduce Construction Costs

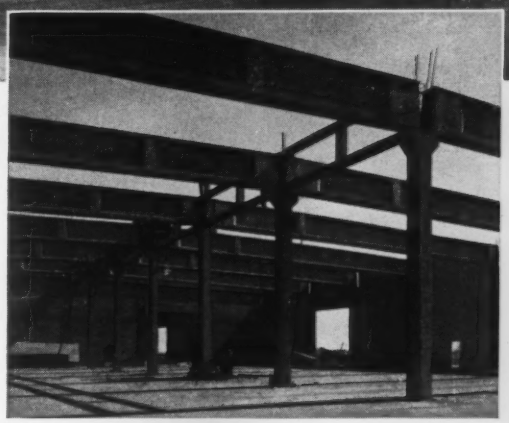
The above photo shows the "Cotton Warehouse" owned by the Port of Long Beach, Calif. It is 150 ft. wide and 1200 ft. long and has precast concrete walls, frame and roof and precast, prestressed concrete roof girders that span 75 ft. from the outside walls to a single row of interior columns down the center of the building.

This structure is an example of the savings that result from the use of precast and prestressed concrete construction. A substantial reduction in construction time resulted from (1) starting the precasting operations at the same time that the foundation work was begun, (2) re-using the formwork frequently and (3) casting the structural units horizontally at a convenient height for the workmen. This plan allowed the workers to repeat the same operations many times. Better craftsmanship and higher quality concrete were the result.

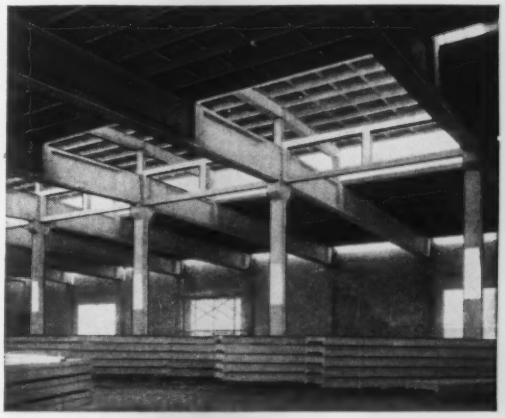
Structures using precast and prestressed concrete units have all the advantages of conventional concrete construction. They can be designed and built to conform with all applicable building codes—anywhere. And they meet all structural requirements of great strength and durability, resistance to severe weathering, long life and ***low-annual-cost*** service. In addition, they can be built to withstand violent lateral forces caused by earthquakes, hurricanes or atomic blasts.

For additional information about precast or prestressed concrete construction write for free illustrated literature. It is distributed only in the United States and Canada.

PORTLAND CEMENT ASSOCIATION
Dept. 6-13, 33 W. Grand Ave., Chicago 10, Ill.
A national organization to improve and extend the uses of portland cement and concrete . . . through scientific research and engineering field work



Top photo: general view of warehouse at Long Beach, Calif. Exterior longitudinal walls are precast concrete panels 30-ft. high, 23-ft. wide and 6 in. to 8 in. thick. Photo above shows 56 in. deep, I-shaped girders supported on cast-in-place wall columns and precast interior columns. Span of the precast girders is 75 ft.



Roof constructed of precast concrete channel slabs resting on prestressed girders and precast monitor frames. Warehouse designed by the office of the late J. H. Davies, consulting structural engineer. Structural engineer was James R. Bole of Long Beach, Calif. Contractor was Johnson-Western Constructors of San Pedro, Calif.

SONOTUBES®
form full, half and quarter-round concrete columns!

Kentucky State Fairgrounds and Exposition Center, Louisville, Ky. Fred Elswick & Associates, architects and engineers. Robert Simmons Construction Co., contractors.

SONOTUBE®
FIBRE FORMS
for round columns of concrete

The contractors for the Stadium, Coliseum, Exposition Bldg. and the Livestock Bldg. at the Kentucky State Fairgrounds used the versatility of low-cost SONOTUBES to great advantage.

In this construction, many round concrete columns of varying diameters and heights were erected as well as half-round and quarter-round columns. SONOTUBES also permitted the integration of the concrete beams with the columns. SONOTUBES were selected for the formwork because they can be easily sawed on the job to required lengths as well as to the required shapes for other than full round columns. SONOTUBES are easily handled because they are lightweight and easily erected because they require minimum bracing. SONOTUBES save time, labor and money.

SONOTUBE Fibre Forms are available from 2" to 36" I.D. up to 50' long. Order in specified lengths if you desire. Use Sonoco's patented "A-Coated" SONOTUBES for finished columns, wax-coated also available. Use SONOTUBES on your next job!

For full information and prices, write

sonoco — "Serves the World's Paper Carriers" — REG U.S. PAT. OFF.

SONOCO PRODUCTS COMPANY
CONSTRUCTION PRODUCTS DIVISION
HARTSVILLE, S. C.

LOS ANGELES, CAL. 5955 SOUTH WESTERN AVE.
MONTCLAIR, N. J. 14 SOUTH PARK STREET
AKRON, IND • LONGVIEW, TEXAS • BRANTFORD, ONT • MEXICO, D. F.

Deceased

(*Continued from page 100*)

engineer for the Metropolitan Water District in charge of design work on the Colorado River Aqueduct. He was one of the first civil engineers employed by the U. S. Bureau of Reclamation, with which he was connected from 1902 until 1920. His assignments with the Bureau included resident engineer on Pathfinder Dam in Wyoming and engineer in charge of construction of Vandalia and Sherburne dams in Montana. He retired several years ago after war work for the government on high explosives projects. Mr. Branch was a graduate of the University of North Carolina.

Walter Thompson Brooks (A.M. '39), age 81, former president of the Shawnee-Mission Water Company, Kansas City, Mo., died there on March 15. A native of Kansas City, Mr. Brooks graduated from Kansas University with a civil engineering degree in 1897. He worked at one time for the Clark E. Jacoby Engineering Company as a specialist in land reclamation and flood control. In 1928 he became president and general manager of the Shawnee-Mission Water Company. In 1941 he sold the company to the Kansas City Suburban Water Co., remaining as manager until his retirement in 1946.

Joseph G. Conrath (M. '54), age 49, civil engineer and partner in the firm of Conrath & Powell, consulting engineers of New York City, died at his home in Erie, Pa., on April 2. A civil engineering graduate of Lehigh University, class of 1929, Mr. Conrath had been designer for Gibbs & Hill on construction of the Pennsylvania Station building in New York City and field engineer for the Pennsylvania Railroad on electrification of its freight tracks from New York to Philadelphia. Later he was design engineer for the Bethlehem Steel Co.; principal engineer for the Bethlehem (Pa.) Municipal Water Authority; and assistant engineer, Caribbean Architect Engineers, N.Y., on design of water supplies for Army airfields. He had been in private practice since 1945.

John Arthur Elliott (M. '27), age 69, Texas division engineer for the U. S. Bureau of Public Roads for the past eighteen years, died at his home at Fort Worth on March 3. A civil engineering graduate of the University of Washington, Mr. Elliott had been with the Bureau since 1918 and had served as district engineer in several localities. As engineer for the Oregon State Highway Department earlier in his career, he was responsible for the location and construction of the famous Columbia River Highway in Hood and Wasco counties.

Harold P. Fisher (M. '28), age 68, for the past five years structural engineer for the Gawley Construction Co., of Chicago, Ill., died at his home there recently. A civil engineering graduate of the Univer-

(*Continued on page 104*)

How Change to High-Strength Bolting Speeded Erection of Steelwork

This 19-story structure in Rockefeller Center's community of impressive office buildings is an addition to the U. S. Rubber Building. It is one of New York's first projects to be erected with high-strength bolting.

It was originally intended to use riveting to join the structural members. After the first story was erected in this manner, it was decided to use high-strength bolting for the remainder of the job, with the result that erection of the 4190-ton frame proceeded more swiftly, at the same time providing stronger joints. Bethlehem High-Strength Bolts were used in connecting many of the structural members.

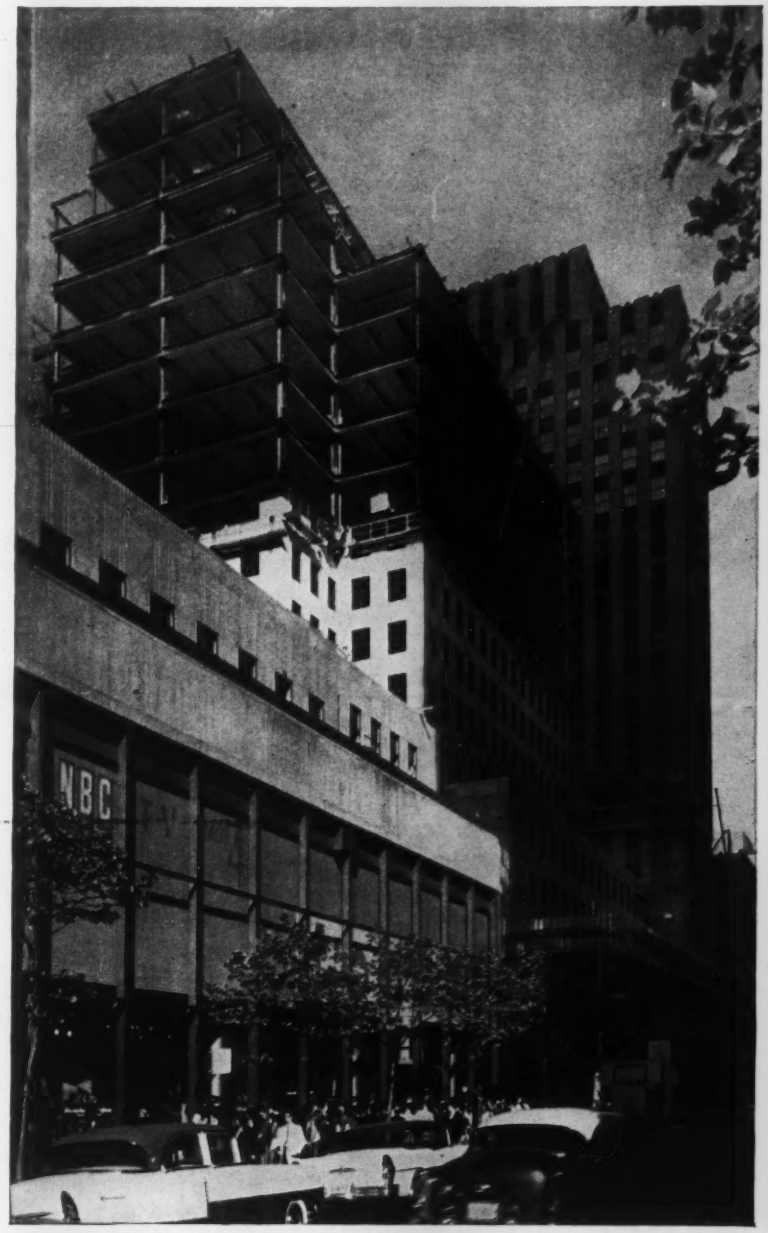
Bethlehem High-Strength Bolts are ideal fasteners for connecting structural steel. They can be installed quickly by a two-man crew, using a holding wrench and a calibrated impact wrench. What's more, the torque applied by the impact wrench provides joints which stay tight for all time.

Another advantage of high-strength bolting is relative freedom from noise, as the impact wrench is less noisy than a riveting gun. There's no cause for concern about fire hazards, either, for with the bolts installed cold, heating equipment is not necessary.

Bethlehem High-Strength Bolts are made of carbon steel, and are heat-treated by quenching and tempering, so as to meet the requirements of ASTM Specification A-325.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation
Export Distributor: Bethlehem Steel Export Corporation



Addition to U. S. Rubber Building, New York City. *Architects:* Harrison & Abramovitz; *General Contractor:* George A. Fuller Co.; *Structural Steel Contractor:* The Ingalls Iron Works Co.; *Structural Engineers:* Edwards & Hjorth

BETHLEHEM STEEL

BETHLEHEM STEEL

ANOTHER PROBLEM SOLVED BY SPENCER, WHITE & PRENTIS

FLOOD UNDERMINES FOUNDATION —AID RUSHED WITHIN HOURS

1. DANGER OF COLLAPSE AT THIS CORNER
2. TEMPORARY SHORES

Project: Shoring and Underpinning Machine Shop, Chase Brass Co. Plant, Waterville, Conn.
Engineers: Lockwood Greene Engineers, Inc. New York City

The rampaging waters of Connecticut's Naugatuck River, swollen by Hurricane Diane, had ripped a 25-ft. hole in the Northeast corner of this Chase Brass plant. Collapse threatened.

Emergencies are no novelty to Spencer, White & Prentis—we've handled many of them in our 36 years. In this instance, the rush-call reached us Friday. By Saturday morning remedial work was under way, continuing through the weekend until the structure was made safe.

Maintaining complete facilities and permanent personnel, Spencer, White & Prentis is ready-for-action at all times.

CATALOGUE ON REQUEST

Spencer, White & Prentis

FOUNDATIONS · PILING · UNDERPINNING · SHORING · COFFERDAMS · SPECIAL SERVICES

10 EAST 40th STREET, NEW YORK 16, N.Y.

DETROIT: 2033 PARK AVE. · CHICAGO: 228 NORTH LaSALLE ST. · WASHINGTON, D. C.: TOWER BLDG.
IN CANADA: 700 BAY ST., TORONTO · 2032 ST. CATHERINE ST. WEST, MONTREAL

Deceased

(*Continued from page 102*)

sity of Notre Dame, class of 1906, Mr. Fisher worked for several railroads, coal companies and coaling stations. He had been with the Wieboldt Construction Co., of Chicago, as estimator, engineer, secretary and treasurer, and with the Lally Column Company, of Chicago, as engineer in charge of the engineering department. For a number of years Mr. Fisher was in private practice.

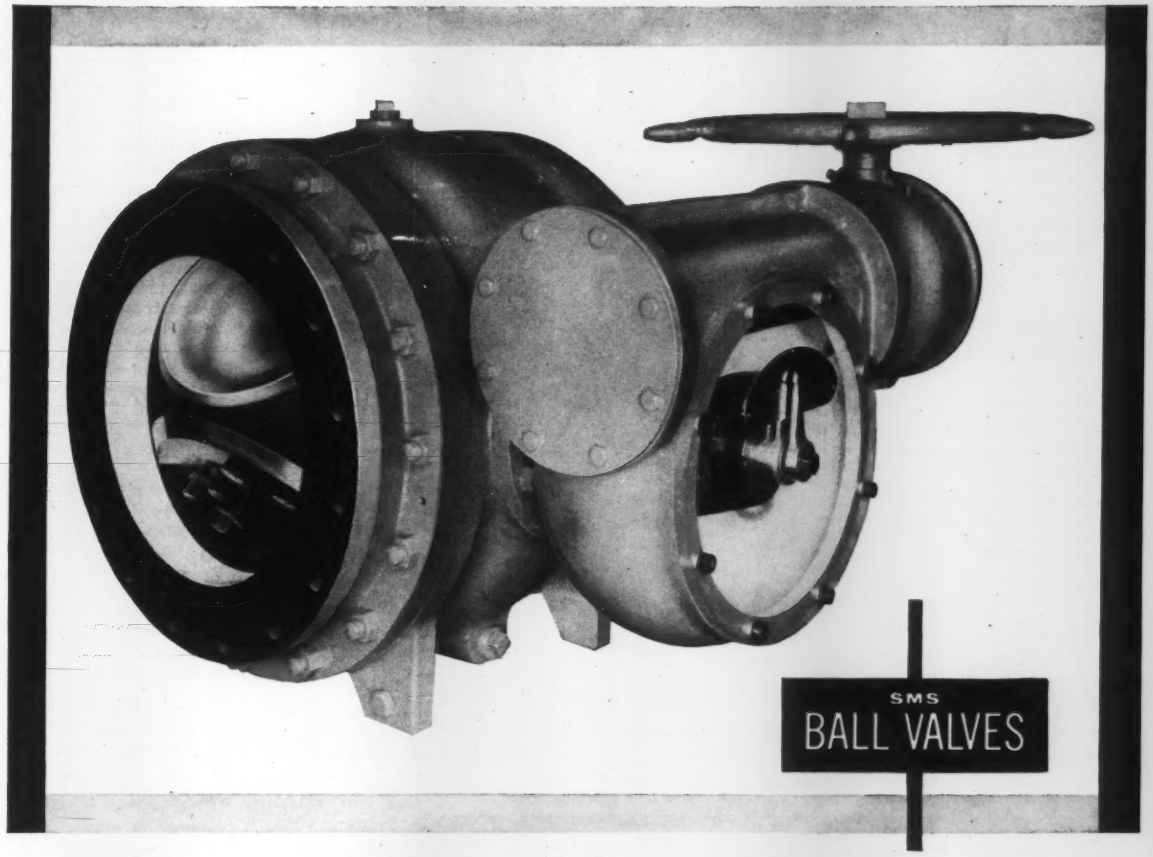
DeMarcus D. Forgey (M. '54), age 70, district engineer, Seattle district, Washington Department of Highways, died at his home in Seattle on April 6. Mr. Forgey had been with the Department of Highways for many years, his assignments including district construction engineer for the Spokane district and district engineer for the Wenatchee and Vancouver districts. He had been district engineer at Seattle since 1951. He was a graduate of Washington State College.

David Warner Fry (A.M. '20), age 60, principal assistant engineer, office of the chief engineer, Baltimore and Ohio Railroad, Baltimore, Md., died there on March 30. A graduate of Virginia Polytechnic Institute, class of 1910, Mr. Fry began his career with the Mexico Northwestern Railway. In 1911 he entered the service of the Baltimore and Ohio, advancing to senior assistant engineer in 1941 and principal assistant engineer in 1943. Mr. Fry engaged in studies and investigations concerning government projects affecting the railroad and made many studies for physical improvement of the line.

Gavin Hadden (M. '25), age 67, civil engineer and special assistant, Department of Defense, Washington, D.C., died at his home in Alexandria, Va., on March 10. He had been in the Department of Defense and its predecessor, the Construction Division of the War Department, since 1940. He was the historian for the Manhattan Project, which developed the first atomic weapons, and more recently had been in the Special Weapons Division of the Defense Department. A graduate of Harvard University, class of 1910, Mr. Hadden received his civil engineering degree from Columbia University in 1912. He served in World War I as captain in the Army Corps of Engineers. In private practice for 21 years, Mr. Hadden designed and co-designed many athletic stadiums, including those at Cornell, Northwestern, and Franklin Field in Philadelphia, and was inventor of the crescent-type stadium, rolling grandstands, and trajectory-type indoor tennis courts.

Alfred Ronald Hiatt (M. '43), age 58, retired civil engineer with the Vicksburg District of the Corps of Engineers, died on March 30. Mr. Hiatt went to work with the Memphis District of the Corps of Engineers in 1932, and transferred to the Vicksburg District in 1936. At the time of his retirement last September he was chief of the Planning and Reports Branch of the Engineering Division. He was a graduate of Purdue University, and a veteran of World War I.

(*Continued on page 106*)



FLOW ITSELF HELPS MAKE SMS BALL VALVES EASY TO CLOSE

Flow velocity actually assists the closing operation of SMS Ball Valves. With the hydraulic action boosted by the powerful leverage of the simple link and lever mechanism (visible through the lucite cover of the demonstration model above), the valve is remarkably easy to close. The wedging action of the metal-to-metal seats assures drop-tight closure.

In the open position, the valve is like a straight length of pipe. Pressure drop and turbulence are kept to a minimum, resulting in lower pumping costs and longer valve life.

The high quality and performance characteristics of SMS valves are guaranteed by more than 75 years of research and engineering. To get detailed information about our complete line of Ball Valves, Rotovalves and Butterfly Valves, contact your local representative, or write to the S. Morgan Smith Company, York, Pennsylvania.

S. MORGAN SMITH

AFFILIATE: S. MORGAN SMITH, CANADA, LIMITED, TORONTO

HYDRAULIC TURBINES
GATES & HOISTS
TRASH RAKES
PUMPS
ACCESSORIES
HYDRODYNAMICS
ROTOVALVES
FREE DISCHARGE VALVES
BALL VALVES
CONTROLLABLE-PITCH SHIP PROPELLERS
BUTTERFLY VALVES

CONVENIENCE-ENGINEERED FOR FAST, ACCURATE WORK

General Leveling — Measuring Heights
Checking Grades — Topographic Mapping

Compact, dependable instrument made for lifetime service. Supplied with 4 scales held in milled slide ready for immediate use without removing and reversing arc frame. Precision controlled index arm gives accurate readings. Bubble magnifier adjusts internally—no eyepiece to retract for carrying . . . no re-focusing for every job.

4 STANDARD SCALES READY FOR INSTANT USE
- Degree
- Per Cent
- Topographic
- Chainage Corrections

$33.00
Complete with all 4 commonly used scales and saddle leather case. Abney Level Handbook included.

At your Dealer or Send Check or Money Order (No C.O.D's)

LEUPOLD ABNEY LEVEL HANDBOOK

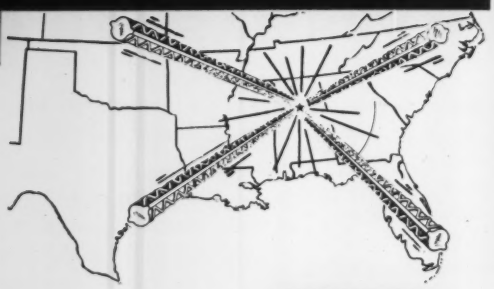
Illustrates and describes how to make full use of your Abney Level. Furnished with each Abney Level, or send 25c per copy

LEUPOLD & STEVENS INSTRUMENTS, Inc.
4445 N.E. GLISAN ST. · PORTLAND 13, ORE.

Write for FREE folder P 55 on LEUPOLD Levels for Engineers & Builders

PROMPT
DELIVERY
QUALITY

Concrete Reinforcing Bars from CONNORS



When you need Reinforcing Bars PDQ, call on Connors. Exceptional mill flexibility, convenient mid-South location, mean job-site delivery anywhere in the South in a matter of hours.

Excellent truck and rail transportation backed by Connors' traditional rapid, accurate service, assure you the steel you need when you need it.

Fabricated to your exact specifications, Connors' bars are tagged and bundled for quick identification.

CONNORS' PRODUCTS
- Reinforcing Bars
- Merchant Bars
- Structural Shapes
- Hot Rolled Strip
- Studded T Fence Posts
- Highway Sign Posts
- Bulb Tees
- Special Sections

HKP

CONNORS STEEL DIVISION
H. K. PORTER COMPANY, INC.
P. O. BOX 2562 — BIRMINGHAM, ALA.

Deceased

(*Continued from page 104*)

Earl H. Knepper (M. '43), age 74, retired construction engineer of Los Angeles, Calif., died at his home there recently. From 1941 until his retirement in 1954, Mr. Knepper was with Koebig & Koebig, Los Angeles engineers, on the design of defense and other projects. As an engineer and contractor in Los Angeles from 1922 to 1933, Mr. Knepper designed and built many structures, including the Pacific Freight Line terminals. Earlier he had been with Guggenheim Brothers on mining developments in the Orient, and for eight years was chief engineer and manager of the Davidson Construction Co., Los Angeles. He was a graduate of Stanford University, and a veteran of World War I.

Edwin Andrew McDougle (A.M. '50), age 50, materials engineer with the Tennessee Valley Authority, died at his home in Knoxville, Tenn., on March 2. Early in his career Mr. McDougle worked for the North Carolina Highway Commission and the Iowa Highway Commission. In 1933 he joined the Tennessee Valley Authority at Watauga Dam at Elizabethton, Tenn., as assistant materials engineer, and by 1947 was in full charge of laboratory testing, concrete mix design, and field inspection in connection with concrete construction at Boone Dam, Johnson City, Tenn. Mr. McDougle studied at Duke University.

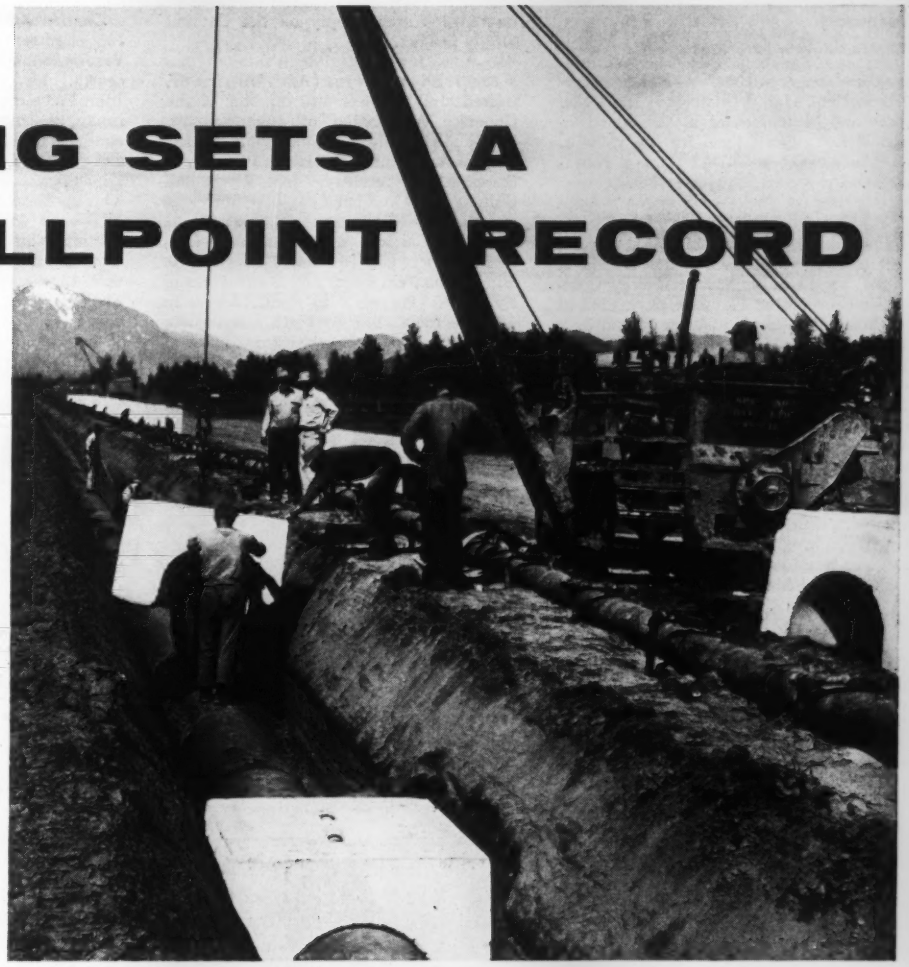
E. A. McDougle

Willis Limle Ogden (A.M. '53), age 33, sanitary engineer with the Lakeside Engineering Corp., Chicago, Ill., died at his home at Annawan, Ill., on March 26. A graduate of the University of Illinois, class of 1943, Mr. Ogden had been in the U. S. Public Health Service district offices in New Orleans and Cleveland. In 1946 he was awarded a scholarship by the National Infantile Paralysis Foundation for graduate study in sanitary engineering at Harvard University. Later he was sanitary engineer with the Yeomans Bros. Pump Co., Chicago, and had been with the Lakeside Engineering Corp. since 1953.

Sivert Edward Olsen (A.M. '48), age 51, resident engineer with Uhl, Hall & Rich, consulting engineers on the St. Lawrence River power project near Massena, N.Y., died suddenly in a Montreal hospital on March 25. Mr. Olsen's early career was spent with the Michigan State Highway Department supervising road and bridge construction. In 1936 he joined the design section of the Tennessee Valley Authority at Knoxville as structural engineer in charge of office engineering on construction of dams, advancing to assistant

(*Continued on page 108*)

STANG SETS A WELLPOINT RECORD



Note shovel marks next to concrete weight in foreground of photo. This clearly indicates how well the earth is stabilized—no sloughing—no extra hand work required.

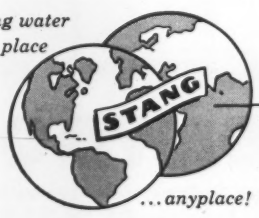
2300 FEET OF 30-INCH PIPELINE

laid in one day!

Visualize more than a mile of header pipe with sufficient Stang Wellpoints to lower ground water level from 6 to 15 feet below subgrade *in 2000 foot sections.* That approximates the amount of dewatering equipment that Stang utilized in order to maintain a 1650 foot daily average (with a single-day high of 2300 feet) for the first two weeks on the job—amidst almost constant rainfall.

This 150 miles of 30-inch natural gas pipeline through southern British Columbia is being laid for the Pacific Northwest Pipeline Corporation by Sparling-Davis Co., Ltd. of Canada. In order to complete the 24 miles of dewatering required on the job within approximately 60 working days Stang field engineers contemplate stepping up the working schedule sufficiently to end up with a 2000 foot daily pipeline installation average for the entire job. Don't slow down your production because of groundwater—use Stang Wellpoints and engineering services to protect your job profits!

Putting water in its place



WRITE FOR BULLETIN 100-C,

JOHN W. STANG CORPORATION

Engineers and Manufacturers of Dewatering Equipment, Wellpoint and Pumping Systems
Dewatering Planning—Equipment—Service

BELL, CALIFORNIA	OMAHA, NEBRASKA	TACOMA, WASHINGTON	TULSA, OKLAHOMA
8221 Atlantic Avenue	2123 South 56th Street	2339 Lincoln Avenue	4026 South Urbana Street
Telephone: LUdlow 2-7421	Telephone: Walnut 7796	Telephone: Broadway 4362	Telephone: Riverside 2-6929

564

Deceased

(*Continued from page 106*)

project manager in 1954. As resident engineer for Uhl, Hall & Rich since 1955, Mr. Olsen was instrumental in the construction of Long Sault Dam for the vast St. Lawrence development. He was a graduate of Michigan State University.

John Smith Siverts (M. '51), age 65, architectural supervisor with Giffels & Vallet, Inc., on the Atomic Energy Commission project at Paducah, Ky., died at his home in Miami, Fla., on March 5. A graduate of the University of Minnesota in 1912, Mr. Siverts had been assistant chief engineer for the Minnesota Mineral Lands Department at Hibbing, Minn., and resident engineer inspector for the Public Works Administration at St. Paul, Minn., and Omaha, Nebr. For twelve years he had a civil engineering practice, specializing in concrete work. More recently he was with the Maxon Construction Co. on construction of various Navy depots and as construction superintendent on the AEC's Oak Ridge Project.

Jay A. Stilson (A.M. '13), age 86, retired civil engineer of Guelph, Ontario, died there on February 11. Active in engineering circles in both the United States and Canada for over fifty years, Mr. Stilson had worked in the Detroit city engineering department; for the Manitoba Bridge & Iron Works, Winnipeg; and the American Transit Co., Detroit. He had also been with the Rapid Transit Commission of Detroit as designing engineer in charge of the preparation of plans and cost estimates of subway and elevated railway structures. He retired in 1944.

William S. Swanson (A.M. '24), age 65, structural engineer with the Bethlehem Steel Company at St. Paul, Minn., died there recently. Mr. Swanson started his career in 1919 with the Kalman Steel Company of St. Paul. This concern was later absorbed by Bethlehem Steel, and Mr. Swanson continued his career with that company.

Oscar Gowen Thurlow (M. '25), age 75, who retired recently as consulting engineer for the Commonwealth and Southern Corporation and the Alabama Power Company, died recently in Florida. His home was in Birmingham, Ala. In 1912 Mr. Thurlow joined the staff of the Alabama Power Company, which he later served as vice-president and chief engineer. He was consulting engineer for the company and for Commonwealth and Southern from 1930 on. He had also been consulting engineer to the government on the design of Muscle Shoals Hydroelectric Plant and Wilson Dam, and was a member of the original Engineering Board appointed to study and review the St. Lawrence Power Project. Mr. Thurlow was a graduate of Massachusetts Institute of Technology. His early experience included design work for the New York Board of Water Supply on the Catskill supply project.

Albert Edward Wynn (A.M. '19), age 67, retired civil engineer and director of the Concrete Association of Johannesburg, South Africa, died at his home in the Hogsback Mountains, Eastern Province of South Africa, recently. Mr. Wynn had been designer and chief engineer of special structures with the Truscon Steel Co. at Toronto, Canada, and Syracuse, N.Y., and district engineer of Thompson & Binger Inc., engineers and contractors of Syracuse. He went to South Africa in 1940 to found the Concrete Association, retiring in 1952. He was a graduate of Birmingham University in England.

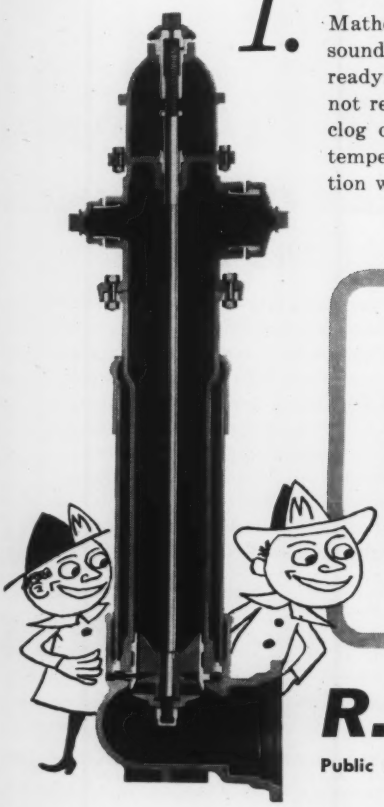
Charles Addison Young (M. '44), age 70, engineer and surveyor of Mount Vernon, N.Y., died at his home there recently. Mr. Young was associated with John F. Fairchild for many years as transitman, assistant engineer and engineer in charge of office and field work on municipal and private projects. In 1917 he became an associate in the firm of Hollister & Young, Inc., working on the Ordinance Depot at Middletown, Pa., and bomb loading plant at Port Penn., Del. Mr. Young was in private practice from 1933 to 1942 when he joined Fuller & Co., Inc., of Bridgeport, Conn., as staff engineer in charge of planning, directing and supervising design and construction. He returned to private practice in 1947.

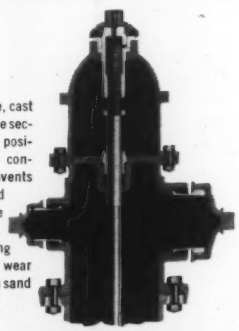
SPECIFY MATHEWS FOR

You need ask two questions

1. **Will they be ready for instant use in an emergency?**

Mathews Hydrants are so simply and soundly constructed that they are always ready. Water, ice and sandy deposits cannot reach key parts to rust or freeze, or clog operation. In any weather and all temperatures, Mathews Hydrants function with a minimum of maintenance.





Stuffing box plate, cast integral with nozzle section, provides a positively leakproof construction. It prevents any water or sand from reaching the operating thread. No rusting, freezing or clogging. No wear on thread through sand abrasion.

R. D. WOOD

Public Ledger Building, Independence Square
Philadelphia 5, Pa.

New Publications

Traffic engineering . . . How some Wisconsin cities solve their traffic problems is the subject of a new publication of the University of Wisconsin Extension Division. Entitled "Traffic Engineering in Wisconsin," the volume contains the proceedings of an Institute on Traffic Engineering held at the university last year. It sells for $3.75, and may be obtained from the Book Store of the University of Wisconsin Extension Division, Madison, Wis.

Highway safety . . . Findings of the State Roads Commission of Maryland and the Johns Hopkins University in a recent joint study of the dynamics of vehicle impact against highway guardrails make up the university's Technical Report No. 5. Authors of this (the final) report are Robert S. Ayre, A.M. ASCE, Joel I. Abrams, J.M. ASCE, and Milton A. Hilger. Inquiries should be sent to the Johns Hopkins University, Department of Civil Engineering, Baltimore, Md.

Timber connectors . . . How six different types of timber connectors can be used in attaining tighter joints in both light and heavy wood construction is explained in the 1956 edition of "Teco Products and Services for the Users of Wood and Forest Products," just issued by the Timber Engineering Company, research affiliate of the National Lumber Manufacturers Association. Free copies are available from the Timber Engineering Company, 1319—18th Street, N.W., Washington 6, D.C.

Tilt-up construction . . . The recent fourth edition of the "Manual of Tilt-up Construction" retains the basic information in the third edition, while including much new material on erection and a completely new approach to the problem of prestressing tilt-up wall panels. Copies are $12.50 each, with discounts available to schools, libraries, and booksellers. Orders should be sent to the author and publisher, F. Thomas Collins, P.O. Box 208, San Gabriel, Calif.

High-strength steel bolts . . . To facilitate reference to the Specifications for Assembly of Structural Joints Using High Strength Steel Bolts, the Engineering Foundation's Research Council on Riveted and Bolted Structural Joints has released an appendix to the specifications. Both the specification and appendix are included in the latest printing. Copies may be obtained from the Industrial Fasteners Institute, 1517 Terminal Tower, Cleveland 13, Ohio.

European technical digests . . . The best articles from European technical and industrial journals, translated and digested, are now available to American industry on a monthly basis. Subscriptions are handled by the O.E.E. C. Mission Publications Office, 2000 P. Street, N.W., Washington 6, D.C. Rates are $24 a year, or $2.50 a single issue.

Concrete . . . Various base-course materials used in concrete pavement construction have been evaluated by load-transmission tests and the findings correlated with triaxial test results by the Civil Aeronautics Administration. A complete report of this research, identified as C.A.A. Technical Development Report No. 269, is available from the Office of Technical Services, U.S. Department of Commerce. The price is 50 cents.

Concrete research . . . Reprints of several reports of important research carried out under the guidance of the Reinforced Concrete Research Council may be purchased at 50 cents each. They are: Bulletins No. 1, "A Study of Combined Bending and Axial Load in Reinforced Concrete Members"; No. 2, "Inelastic Behavior in Tests of Eccentrically Loaded Short Reinforced Concrete Columns"; No. 3, "What Do We Know About Diagonal Tension and Web Reinforcement in Concrete"; No. 4, "Yield-Line Theory for the Ultimate Flexural Strength of Reinforced Concrete Slabs"; and No. 5, "Shearing Strength of Reinforced Concrete Column Footings." Orders should be forwarded to R. F. Blanks, Chairman, Reinforced Concrete Research Council, 510 Denver National Bank Building, Denver, Colo.

Engineering education and industry . . . The proceedings of the ninth (1955) annual meeting of the Industry-Faculty Conference, held at Louisiana State University, make up Engineering Experiment Station Bulletin No. 52. The program theme, "The Engineering School, the Engineer and Industrial Development," were discussed from the viewpoints of the educator, industry (with emphasis on executive development), and associated organizations. Copies, priced at $1.00 each, are for sale by the Engineering Experiment Station, Louisiana State University, Baton Rouge 3, La.

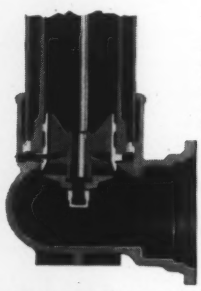
Welding . . . To keep up with the rapid development of new welding materials, processes, and techniques, the American Welding Society has devised a new method of publishing the fourth edition of its classic "Welding Handbook." The handbook is being divided into five 500-page sections punched for insertion in a convenient binder. Each of the sections will be revised and brought up to date once in five years in a publishing pattern that will operate permanently over a five-year cycle. Inquiries should be addressed to the American Welding Society, 33 West 39th Street, New York 18, N.Y.

Urban transportation . . . Studies of the transportation problem in eight representative American cities ranging in size from Youngstown to Los Angeles make up a recent technical bulletin of the Urban Land Institute, entitled "Crowded Streets—a Symposium on Public Transportation." The studies are packed with ideas for arresting the present trend toward use of private automobiles instead of public transit for moving large numbers of people into and out of high-density districts. Identified as Technical Bulletin No. 26, the 77-page publication is for sale by the Urban Land Institute, 1737 K Street, N.W. Washington, D.C. at $4 a copy.

DEPENDABLE PROTECTION
only
about fire hydrants:

2. Can the hydrant be quickly replaced if broken in a traffic accident?

When you have Mathews Hydrants on the job, neighborhood fire protection can suffer only momentary interruption. A broken Mathews Hydrant can be replaced with a new barrel in less than half an hour, and *without excavating.*



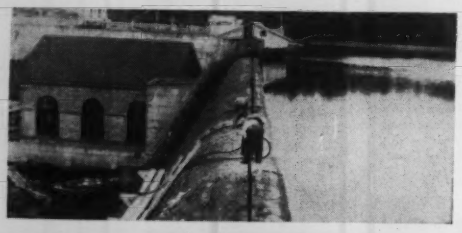
Main valve, true compression type, opens against and closes with water pressure. The higher the pressure, the tighter the valve. When hydrant is broken in traffic accident, there's no leakage with consequent dangerous loss of pressure.

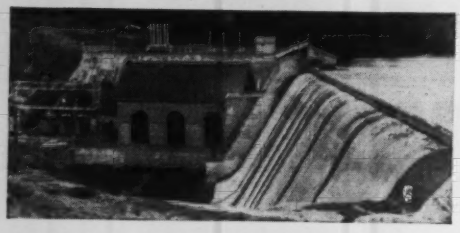
Available for mechanical joint connections

COMPANY

Manufacturers of "Sand-Spun" Pipe (centrifugally cast in sand molds) and R. D. Wood Gate Valves

CEMENT GUN CO. RESTORES DAM with "GUNITE"





The photographs, at left, show a large Ambursen type dam in Northern New England which has been reintegrated with "GUNITE."

The top photograph shows the spalled and eroded condition of the concrete when the Cement Gun Company crews arrived on the job. The surface was chipped back to sound concrete and reinforcing mesh applied. Then the entire downstream surface was blanketed with "GUNITE."

The bottom photograph shows the completed "GUNITE" surfacing of the dam.

This is typical of many dams which we have restored throughout the country. Many similar examples of repair, remodeling and new construction with "GUNITE" are described and pictured in Bulletin B3000. A request on your letterhead will bring a free copy by return mail.

CEMENT GUN COMPANY
"GUNITE" CONTRACTORS
GENERAL OFFICES – ALLENTOWN, PA., U. S. A.

MANUFACTURERS OF THE CEMENT GUN

ELASTIC BEHAVIOR OF STRUCTURAL MEMBERS

"The Frame Constant Method"

by
Odd Albert

Associate Professor of C. E.
Brooklyn Polytechnic Institute

At last, after 30 years of preparation, the book is out! Many new concepts in frame analysis introduced: The Frame Constants, the Characteristic Denominators, Moments and Slopes determined as part of simple progressions, etc.

About 300 pages and 120 charts giving moments, slopes and reactions of beams on 2,3,4,5 and 6 supports. End supports, either free, fixed, or fixed one end and free the other. Loading, either uniform, or one, or several concentrated loads.

Price $6—(three for $15)

OPLA COMPANY
Box 266
Belmar, New Jersey

THE ENGINEER'S CREED

The American Society of Civil Engineers announces the availability of a new supply of "The Engineer's Creed," which originally appeared in the November, 1948 issue of CIVIL ENGINEERING. This new de luxe reprint, 8½ x11", has been produced on lightweight parchment, and is suitable for framing.

Copies available at $1.00 each
Quantity prices on request

American Society of Civil Engineers
33 West 39th Street, New York 18, N. Y.

Please send me.....copies of "The Engineer's Creed"
Payment is enclosed herewith

Name .....

Address .....

City .....

RECENT BOOKS

Advances in Applied Mechanics, Vol. IV

The seven lengthy papers included summarize present knowledge and recent investigations on the following subjects: the turbulent boundary layer; nonlinear elasticity; physical and statistical aspects of fatigue; three-dimensional boundary layer theory; the dislocation theory of plasticity of metals; the Poincaré-Lighthill-Kuo method; and the concept of elastic stability. The references accompanying each paper are indexed by authors, and a subject index to the volume is provided. Edited by H. L. Dryden, Theodor von Kármán, G. Kuerti, and others. (Academic Press, Inc., 125 East 23rd St., New York 10, N.Y., 1956. 413 pp., $10.00)

International Association for Bridge and Structural Engineering, Vol. XV

Five French and eleven English papers are included, with titles and summaries in English, French, and German. Among the English language papers are those dealing with the analysis of suspension bridges by the minimum energy principle; stresses in non-uniformly supported cylindrical tanks; composite action in framed buildings; and design and construction of a reinforced concrete shell structure of non-uniform thickness supported on a roller system. Subjects of the French papers include the plasticity of mild steel as a safety factor; prefabrication of arch bridges; and the design of the Vierendeel girder. (Verlag Leeman, Zürich. 1955. 275 pp., Sw. Fr. 38.00)

Korrosion Metallischer Werkstoffe in Aggressiven Mitteln

A German translation by W. P. Batrakow of a Russian reference book on the corrosion of metal construction materials in actively corrosive media; tabular and graphical data showing corrosion rates of Soviet commercial steels, special steels, and a considerable number of non-ferrous metals and alloys, arranged by the several media: oxygen, air at high temperature, chlorine, fluorine, sulphuric acid, phosphoric acid, and sea water. The physical and chemical properties of the various media are also tabulated. (VEB Verlag Technik, Berlin., 1954. 511 pp., DM 54.00)

Practical Design of Simple Steel Structures, Vol. I

A new edition by David S. Stewart, of a standard British text written as a detailed guide to actual design procedures. This first volume covers the choice of sections; the making of drawings and templates; simple riveted joints of plates; flange-plate and other splices; eccentric riveted connections; wind pressure calculations; and beams. The last two chapters present complete designs of a joist and channel crane gantry girder and of a gallery, suitable for light work, to be attached to existing columns of a workshop. Tables giving properties of rolled sections, rivet values, bolt values, and other data are included in the appendix. (Fourth edition, 1955, Constable and Company, London, Essential Books, Inc., Fairlawn, N.J., 221 pp., $2.90)

Robert Maillart

This volume edited by Max Bill, consists mainly of reproductions of photographs and cross-section drawings of the structures designed by the Swiss engineer Maillart (1872–1940). Brief comments on the structures and extracts from Maillart's writings, for the most part given in French, German, and English, accompany the illustrations. Although most of the book is devoted to

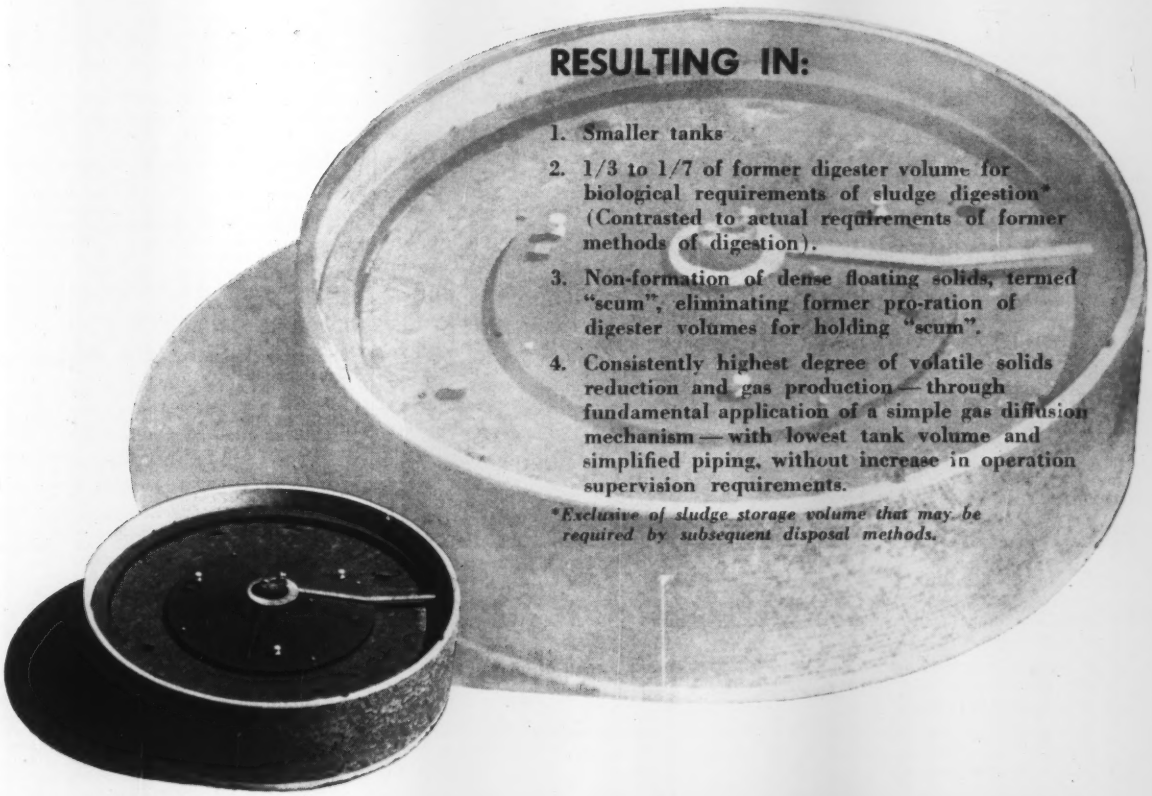
(*Continued on page 112*)

CRP*

CATALYTIC
REDUCTION
PROCESS

PERMITS SMALLER TANKS...

through exclusively highest solids loading for sludge digestion



RESULTING IN:

1. Smaller tanks
2. 1/3 to 1/7 of former digester volume for biological requirements of sludge digestion* (Contrasted to actual requirements of former methods of digestion).
3. Non-formation of dense floating solids, termed "scum", eliminating former pro-ration of digester volumes for holding "scum".
4. Consistently highest degree of volatile solids reduction and gas production — through fundamental application of a simple gas diffusion mechanism — with lowest tank volume and simplified piping, without increase in operation supervision requirements.

*Exclusive of sludge storage volume that may be required by subsequent disposal methods.

Reports Available

Reports describing the PROCESS in detail are available on request. Write to Department F.

*Patents Applied For

fmc

CHICAGO PUMP COMPANY

Subsidiary of Food Machinery and Chemical Corporation

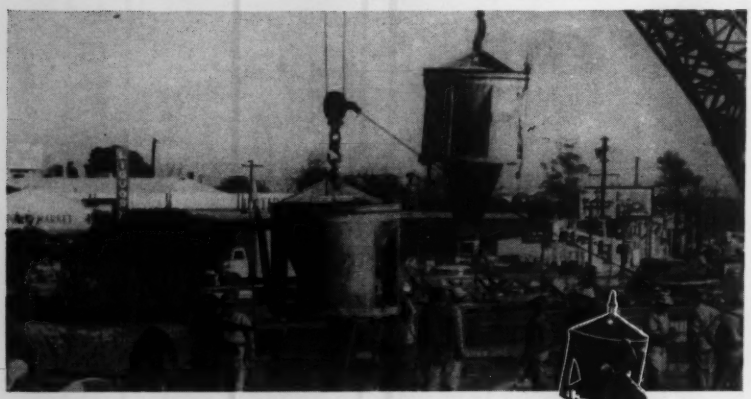
SEWAGE EQUIPMENT DIVISION

422 DIVERSEY PARKWAY • CHICAGO 14, ILLINOIS

Flush Kleen ®, Scru-Peller ®, Plunger, Horizontal and Vertical Non-Clogs Water Seal Pumping Units, Samplers . . . Swing Diffusers, Stationary Diffusers, Mechanical Aerators, Combination Aerator-Clarifiers, Barminutor ®, Comminutors.

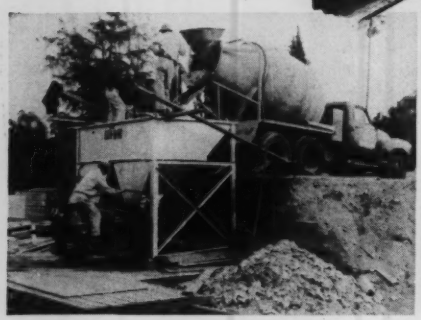
Use Production Line Methods

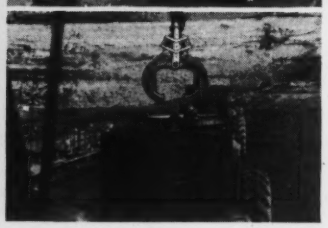
FOR HANDLING CONCRETE



SETTING A FASTER PACE by using two or more concrete buckets is a method for cutting costs used by many contractors on medium size jobs. While one is discharging the other is loading—there is no delay of placing crew or mixers.

FLOOR HOPPERS keep concrete carts moving by serving as storage for concrete. Fill them direct from truck mixer or by bucket if in elevated position.





POWER-CARTS, because they carry more, travel faster and are non-fatiguing, can place 4 to 5 times as much concrete per hour as a push cart even at hauling distances of 1000 feet.

PORTABLE HOPPERS move from job to job easily and save hours of time all the way down the line from mixer to placing crew to finishers because it eliminates waiting time and delay.

New power operated CRANE HOOKS are electrically controlled from the crane cab. They are ideal for picking up and releasing each individual bucket when several buckets are used.

GAR-BRO MANUFACTURING CO. • Los Angeles, California • Peoria, Illinois
General Offices: 2415 East Washington Boulevard, Los Angeles 21, California

GAR-BRO *Ask your dealer for the Gar-Bro Manual...*

the world's most complete line of

CONCRETE HANDLING EQUIPMENT

Recent Books

(*Continued from page 110*)

bridges, one section covers other structures, especially those with mushroom column construction. (Girsberger, Zürich, 1955. W. S. Heinman, 400 East 72nd St., New York 21, N.Y. $11.00)

Fluid Flow in Practice

A concise treatment of selected aspects of the flow of fluids (including slurries) in pipelines and pumps, with some attention given to applications for gases. The volume is made up of six papers covering the following subjects: basic principles; planning piping systems; the selection of valves, pumps, and flow meters; operation and maintenance of equipment; and trends in research. Edited by J. R. Caddell. (Reinhold Publishing Corp., 430 Park Ave., New York 22, N.Y., 1956. 119 pp., $3.00.)

Heating Ventilating Air Conditioning Guide

The new edition of this standard guide to current practice in the field has been brought up to date by additions or changes in sections devoted to heat transmission of building materials, cooling load, chimneys, estimating fuel consumption, central systems for air conditioning, automatic control, automobile air conditioning, and a number of other subjects. (Volume 34, 1956. Published by the American Society of Heating and Air-Conditioning Engineers, 62 Worth Street, New York 13, N.Y. 1696 pp., bound. $12.00.)

Studies in Ancient Technology, Vol. III

Of particular interest to engineers in this volume by R. J. Forbes, of an eleven-volume survey of pre-classical and classical technology is the chapter devoted to crushing, which discusses the introduction of beam and screw presses and of various types of grinding devices. The book deals mainly with techniques for the preparation of foods and beverages, and with such subjects as paint, pigments, inks, salt, cosmetics, and perfumes. (E. J. Brill, Leiden, Netherlands, 268 pp., bound $5.50.)

The Supervision of Civil Engineering Construction

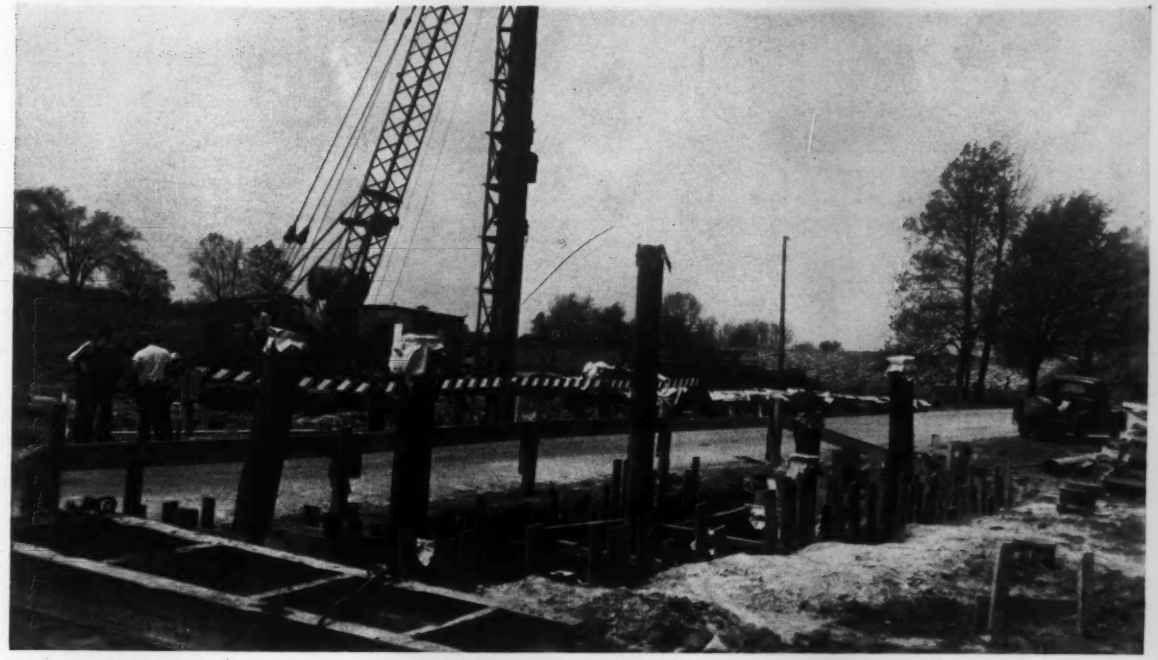
A three-part discussion by A. C. Twort, of British practice in the supervision of medium-sized civil engineering work done under fixed price contract. The first part deals with the site engineer's responsibilities for organization and management and with the administrative and clerical work of the site office. Part II describes how the engineer handles technical problems and shows how engineering operations are carried out in actual practice. The third part considers specifications, billing, and contract drawings. (Edward Arnold (Publishers) Ltd., London, 1955. St. Martin's Press, 103 Park Ave., New York 17, N.Y., $6.00)

Water for the Cities

A history by N. M. Blake, of water supply in New York, Philadelphia, Baltimore, and Boston during the years 1790 to 1860, with brief discussions of the problems of other cities and two chapters covering the development of urban water supply since 1860. The book is essentially social history, but it includes many technical details on the systems discussed. (Syracuse University Press, Syracuse, N.Y. 341 pp., $4.00.)

Staubbewegungen in Grenzschichten

A group of twelve papers dealing with various aspects of the motion of dust at boundary layers: distribution of particles; operation of mechanical dust separators; deposition and sedimentation phenomena; pneumatic transportation investigations; hydrodynamic phenomena in turbulent gas layers; etc. (VDI Berichte, number 6, 1955. Verein Deutscher Ingenieure, Düsseldorf. 56 pp., DM 10.50.)



Piling operations at Structure 53-5, Indiana Toll Road. Pile Diameter: 12", Wall Thickness: .172", Hammer: Vulcan No. 1

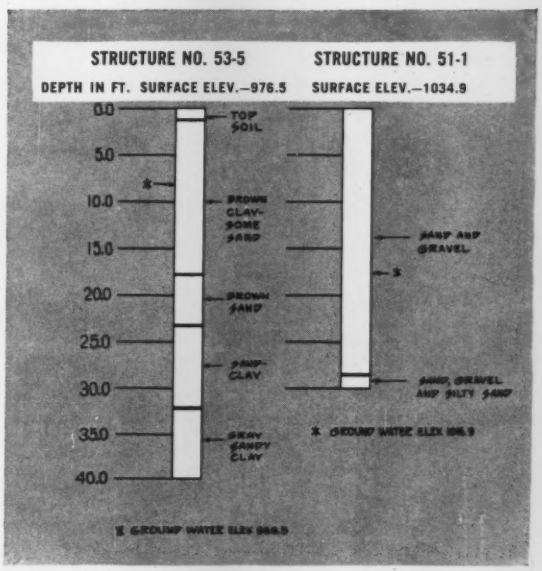
How Armco Pipe Piling Met Varying Foundation Requirements on the Indiana Toll Road

Soil Logs for Typical Grade Separation Structures Illustrate Different Driving Conditions

The soil logs reproduced here illustrate the widely varying conditions encountered at the site of two typical grade separation structures on the Indiana Toll Road. Under structure No. 51-1, hard driving sand and gravel; under structure No. 53-5, relatively easy driving clay.

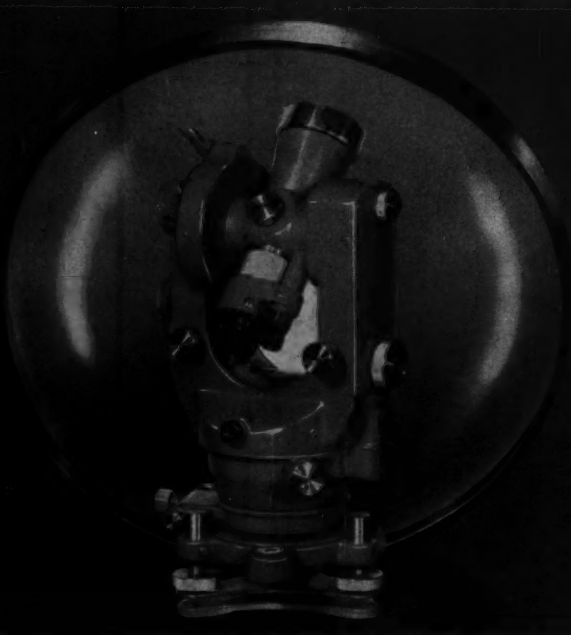
In both cases Armco Pipe Piling provided the efficient answer. It withstood up to 100 blows per foot to reach the required minimum 20-foot penetration at structure 51-1. In the less stable soil at Structure 53-5, penetrations of more than 40 feet were needed to meet the same 30-ton bearing requirement. The constant cross section of Armco Piling made it easy to splice. Cut-offs could be salvaged. And high collapse resistance assured straight piles, easily inspected for watertightness.

Write us about your foundation problems. Your nearby Armco man will be glad to show you performance data on Armco Pipe Piling in a wide range of driving conditions. Armco Drainage & Metal Products, Inc., Welded Pipe Sales Division, 4756 Curtis Street, Middletown, Ohio. Subsidiary of Armco Steel Corporation. In Canada: write Guelph, Ontario. Export: The Armco International Corporation.



ARMCO PIPE PILING

WILD®
HEERBRUGG



WILD T-1 OPTICAL REPEATING TRANSIT

Here is unmatched speed, precision and convenience. Optically and mechanically, it is designed for fast set-up, error-free reading, maximum versatility, and for day or underground use under the most rugged conditions.

TWO MODELS AVAILABLE

New Model
Reading direct to 20 seconds, interpolation to 10 seconds.

Standard Model
Reading direct to 1 minute, estimation to 6 seconds.

Priced at $718 and $700 respectively, F.O.B. Port Washington, N. Y. Tripods extra.

WRITE FOR DETAILED INFORMATION . . . and use the Wild Heerbrugg advisory services without obligation.

WILD HEERBRUGG INSTRUMENTS, inc.
Main at Covert Streets · Port Washington, N.Y. POrt Washington 7-4843
SALES • FULL FACTORY SERVICES

Non-ASCE Meetings

American Society for Engineering Education. Sixty-fourth annual meeting, Iowa State College, Ames, Iowa, June 25–29. For additional information, write Information Service, Iowa State College.

American Society for Testing Materials. Fifty-ninth annual meeting, Chalfonte-Haddon Hall, Atlantic City, N.J., June 17–22. Information from ASTM, 1916 Race Street, Philadelphia 3, Pa.

Materials Handling Training Conference. Third annual conference, Lake Placid, N.Y., June 17–30. Information from James R. Bright, Director, MHTS, Lexington, Mass.

World Power Conference. Fifth World Conference, Vienna, Austria, June 17–23. Further information from U.S. National Committee, Stewart E. Reimel, Secy., c/o Engineers Joint Council, 29 W. 39th Street, New York 18, N.Y.

American Society of Mechanical Engineers. Semi-annual meeting, Hotel Statler, Cleveland, June 17–21. Information from John E. Gerding, 2136 E. 19th St., Cleveland, 15.

Positions Announced

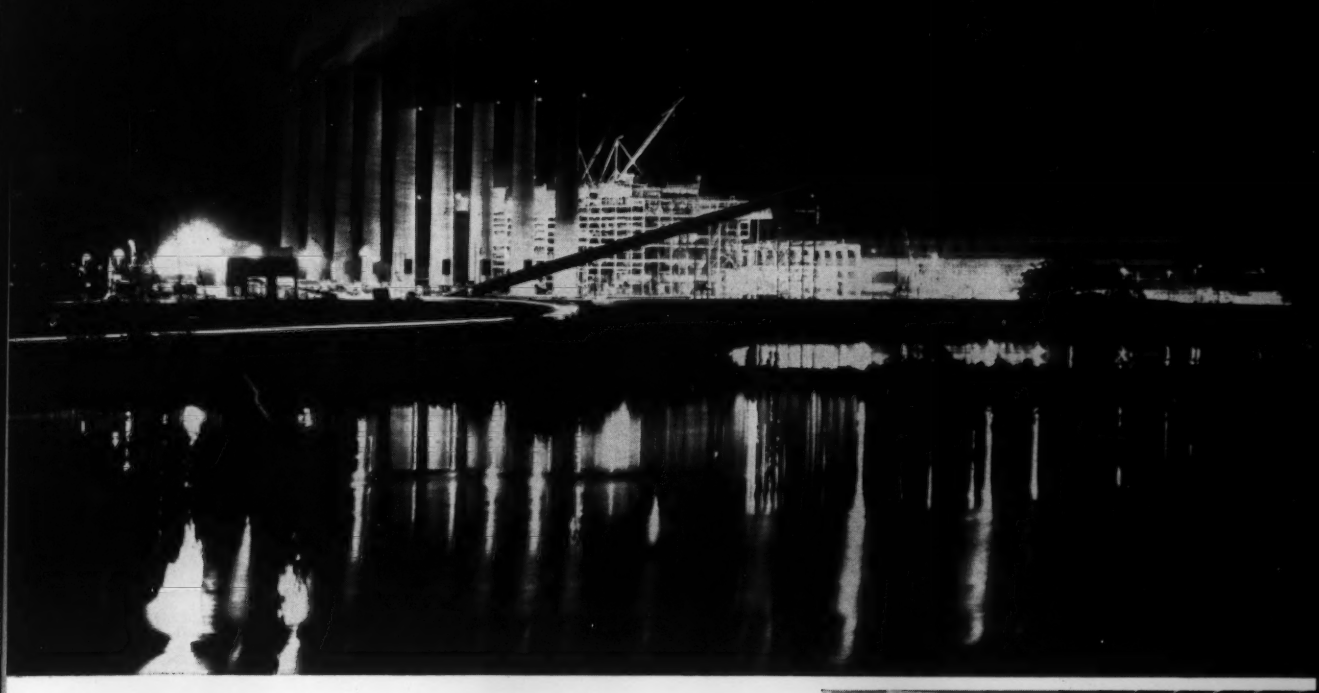
U.S. Geological Survey. The Water Resources Division has need for engineers and scientists well qualified in hydrology, fluid mechanics and hydrodynamics to work on basic research, including problems of open channel flow, flow through porous media, sediment transport, and related problems. The research program is of a continuing nature and offers wide latitude for original work on a variety of challenging projects. Positions under Civil Service, with salaries ranging from $6,390 to $10,300 per annum, are located in Atlanta, Denver, Washington, D.C., and other areas throughout the country. Further information from the chief Hydraulic Engineer, U.S. Geological Survey, Washington 25, D.C.

Norwalk City Planning Commission. The Norwalk Planning Commission announces a vacancy for the position of City Planner, at an annual salary of $5,170. Minimum requirements are a master's degree in city planning and one year's experience, or a degree in planning, architecture or engineering and three years experience, or any equivalent combination of education and experience. Application should be made by letter to Samuel W. Pine, Director of Planning, City Planning Commission, Veterans Memorial Park, Norwalk, Conn.

Army Corps of Engineers. The Pittsburgh District has openings for engineers on river, harbor, and flood control programs, and vital military defense installations and facilities. Engineers GS-9

(*Continued on page 116*)

INGALLS furnishes STEEL MUSCLES



for the WORLD'S LARGEST POWER PLANT

This is the world's largest steam-electric plant, recently completed near Kingston, Tennessee, by the Tennessee Valley Authority. The entire plant has a capability of one million, six hundred thousand kilowatts — about fourteen times that of Norris Dam. With a generator room 895 by 115 feet, a boiler room 868 by 138 feet, and a shop and office area 200 by 205 feet, the main building of the nine unit structure is by itself tremendous; some idea of the whole plant's scope may be realized by considering the twenty two million man hours that went into planning, designing, construction, and secondary services.

View of turbine room in Ingalls-fabricated powerhouse; 7 units in operation; 150,000 kw units in foreground

INGALLS, specialist in steel for power plants, is genuinely proud of having been called upon to fabricate the structural steel used in the powerhouse proper for this monumental operation. It represents one more in a large series of power installations done by Ingalls in twenty two different states, throughout the North, South, East, and Southwest. Wide and intense practical knowledge makes Ingalls ready *now* to help you with both speed and true economy. Your inquiries will be promptly acknowledged.

FABRICATING STEEL IS OUR BUSINESS

THE INGALLS

IRON WORKS COMPANY

BIRMINGHAM, ALABAMA

SALES OFFICES: New York, Chicago, Pittsburgh, Houston, Atlanta, New Orleans

PLANTS: Birmingham, Ala.; Verona, Pa.; Pascagoula, Miss.; North Birmingham, Ala.; Decatur, Ala.

It's the DIFFERENCE
You Can't See
That Counts

You can tell Naylor pipe from other lightweight pipe by its familiar spiral. But what you can't see is the extra performance built into this lockseamed, spiralwelded steel pipe.

First, there's extra strength and safety because of Naylor's exclusive spiral truss which acts as a continuous expansion joint to absorb shock loads, stresses and strains. Next, there's greater collapse strength that lets you use Naylor on both vacuum and pressure. Also, this distinctive structure maintains its true cylindrical form and holds diameter accurately.

Once you use Naylor pipe for air and water lines, ventilating, hydraulicking or dredging, you'll recognize what a difference this extra performance makes.

Write for Bulletin No. 507.

NAYLOR PIPE

NAYLOR PIPE COMPANY
1281 East 92nd Street
Chicago 19, Illinois

Eastern U. S. and Foreign Sales Office: 350 Madison Avenue, New York 17, New York

Positions Announced

(*Continued from page 114*)

(salary range $5,440 to $6,250) and Engineer GS-11 (salary range $6,390 to $7,465). Applications will also be accepted for these positions at the GS-5 and GS-7 grade levels for examination by the Third U. S. Civil Service Region Customhouse, Second and Chestnut Streets, Philadelphia.

Applications for Admission to ASCE, April 7–May 5, 1956

Applying for Member

H. E. Bailey, Oklahoma City, Okla.
Elmer Starling Barrett, Chillicothe, Ohio.
John Gilchrist Bedell, New Orleans, La.
Richard Guy Bond, Minneapolis, Minn.
Edwin Bentley Burdick, Glastonbury, Conn.
Thomas Seddon Burnum, Jr., Caracas, Venezuela.
Frederic Bates Butler, San Francisco, Calif.
Lewis E. Douglas, Los Angeles, Calif.
Lancelot Andrew Fekete, Caracas, Venezuela.
Thomas de Saussure Furman, Gainesville, Fla.
Hillard Durward Gehres, Knoxville, Tenn.
Martin Mayer Gross, Newark, N.J.
John Franklin Harris, Westerville, Ohio.
Edward Wallace Hayes, Seattle, Wash.
Frederick Barker Hill, Orlando, Fla.
Henry Joseph Hoeffer, Atlanta, Ga.
Aubrey Horn, Los Angeles, Calif.
Norman Bridge Hume, Pasadena, Calif.
William Hudson Kester, Pittsburgh, Pa.
Emil William Kunze, Kansas City, Mo.
Max Martin Julius Loeffler, Detroit, Mich.
Howard DeForest Markle, Fairless Hills, Pa.
William Clarence Mason, Birmingham, Ala.
Francis Lee McCormick, Detroit, Mich.
Daniel Metliz, New York, N.Y.
Ivan Bodwell Munson, Olympia, Wash.
Howard Leroy Murphy, Washington, D.C.
Lestle Wilbur Newcomer, El Dorado, Kans.
Edward Lewis North, Westhampton Beach, N.Y.
Robert John Prowse, Concord, N.H.
Riaz Ahmad Quraishi, Karachi, Pakistan.
William Francis Reardon, Schenectady, N.Y.
William Oscar Ree, Stillwater, Okla.
Frank Elvin Rippon, Denver, Colo.
Roy Vernon Sutton, China Lake, Calif.
John Leslie Tingle, Narberth, Pa.
Egbert Nicolaas Petrus Van Es, Dallas, Tex.
Arnold Harry Vollmer, New York, N.Y.
Harold Henry Weiland, Beirut, Lebanon.
James Wyatt Whitehead, Kingsland, Ga.
Anvil Clark Williams, Vicksburg, Miss.

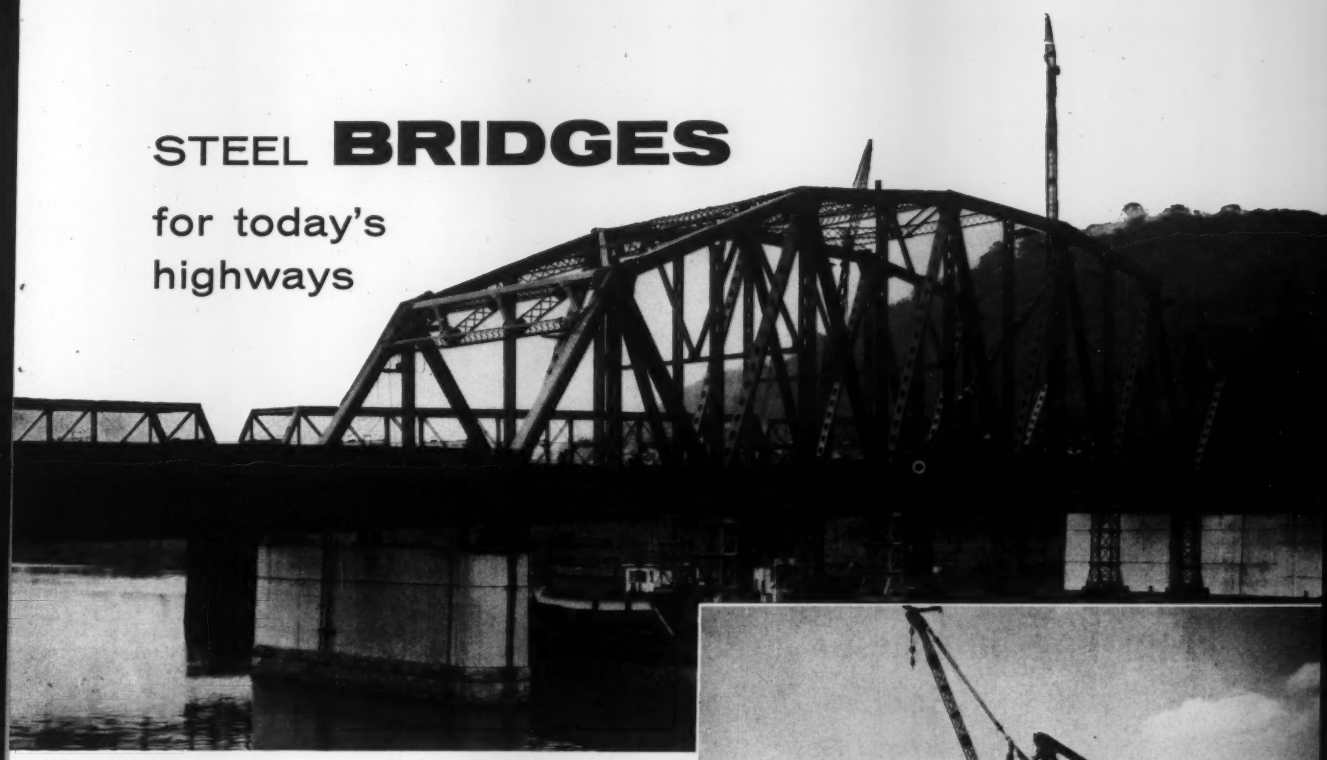
Applying for Associate Member

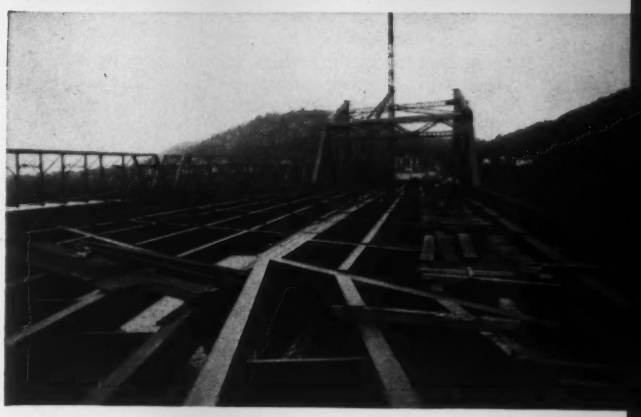
Salih Necdet Akalin, Denver, Colo.
Benjamin Cuba Albritton, San Rafael, Calif.
Bradley Lamar Baker, Baltimore, Md.
Emil Leroy Barcklay, Spokane, Wash.
Raymond Frederick Bartelmes, Alexandria, Va.
Carl Richard Baugher, Roanoke, Va.
Donald Stapp Blaisdell, St. Paul, Minn.
Charles Reagin Breese, Reno, Nev.
Donald Epthorpe Campbell, Cooma, N.S.W., Australia.
Everett Cleveland Clark, Jr., Corpus Christi, Tex.
Elmer Maurice Clark, Denver, Colo.
LeLand Johnstone Cobb, Jr., Tampa, Fla.
Sylvanus Wright Curtiss, Detroit, Mich.
Rayford Roosevelt Dawson, Sandston, Va.
Clement Francois Denize, New York, N.Y.
Fred Nash Denney, Albuquerque, N. Mex.
Harold Edwards Ditzler, Oklahoma City, Okla.
Perry Doty, Shreveport, La.
Albert Armen Erkel, Los Angeles, Calif.
Hugo Angelo Facci, Washington, D.C.
Gabriel Ignacio Forero Rodriguez, Bogota, Colombia.
Vincent Alexander Forss, Easton, Pa.

(*Continued on page 124*)

STEEL **BRIDGES**

for today's highways





PITTSBURGH •DES MOINES

Modern highways demand modern bridges wherever roads must "take to the air." For half-a-century, bridge fabrication and erection have been a vital part of our activities, with every advance in design and method reflected in the dependable structures we build. ● The project pictured is the Fleming Park Bridge at Neville Island, Pittsburgh. With an overall length of 804 feet, the bridge has a through-truss channel span of 360 feet, and will accommodate four lanes of traffic, relieving a serious bottleneck in a heavily-travelled area. ● Let us consult on your bridge requirements, and submit a quotation.

PITTSBURGH • DES MOINES STEEL CO.

Plants at PITTSBURGH, DES MOINES, SANTA CLARA, FRESNO, and CADIZ, SPAIN

Sales Offices at:

PITTSBURGH(25).....3470 Neville Island
NEWARK (2).....251 Industrial Office Bldg.
CHICAGO (3), 1274 First National Bank Bldg.
LOS ANGELES (48)...6399 Wilshire Blvd.
DES MOINES (8).....971 Tuttle Street
DALLAS (1).....1275 Praetorian Bldg.
SEATTLE.....578 Lane Street
SANTA CLARA, CAL., 677 Aliviso Rd.
MADRID SPAIN...Diego DeLeon, 60

PDM STEEL CONSTRUCTION

AISC

Alameda Naval Air Station — Photo courtesy Clyde Sunderland — Oakland

From Bay-bottom to airport runways at record low cost

BITUMULS®-treated sand/clay solves Navy paving problem at Alameda, California

TODAY, the runways of the Alameda (Calif.) Naval Air Station carry the heaviest of aircraft traffic, both in weight and volume.

Yet these same runways were constructed from sand/clay fill, dredged from the bottom of San Francisco Bay at a "bargain cost." The key to this performance and economy has been *Bitumuls Emulsified Asphalt Stabilized Base.* About 3 million sq. yds. of paved area at this Air Station have been built over a period of some 15 years; and during that time the savings as compared with alternate proposals have mounted to more than one million dollars.

Alternate methods considered by the Engineers of the Public Works Office were the construction of asphaltic concrete or macadam types that required the costly importation of crushed aggregate from long distances; or the treatment with Bitumuls of native red rock from the foothills. For these types over 500,000 tons of aggregate would have had to be imported for an average 5" depth of pavement base.

The dredged-in-place sand/clay from the Bay-bottom was stabilized with Bitumuls (about 6% average). This not only gave adequate bearing value at lower cost, but provided other unique advantages, such as:

1. **FLEXIBILITY,** for conformance to minor expected settlement.
2. **RESISTANCE TO ABSORPTION** of capillary moisture from the sub-base (only 3 ft. approximately above tide level).
3. **SPEED OF OPERATIONS** — Mixing Grade Bitumuls could be easily mixed with the damp sand/clay at record speeds compared to other types.

Bitumuls continues to be used at this Air Station in sand/clay mixes of varying designs to provide adequate load-bearing capacities for various types of pavement base. With increasing traffic and heavier loads, many of these areas have been surfaced with wearing courses, such as Asphaltic Concrete, Bitumuls Armorcoats or Surface Treatments.

An important factor in this very successful paving operation was the use of special grades of Bitumuls that are treated for use with hydrophilic or water-preferential sands. Full information on these products is available at a Bitumuls office near you.

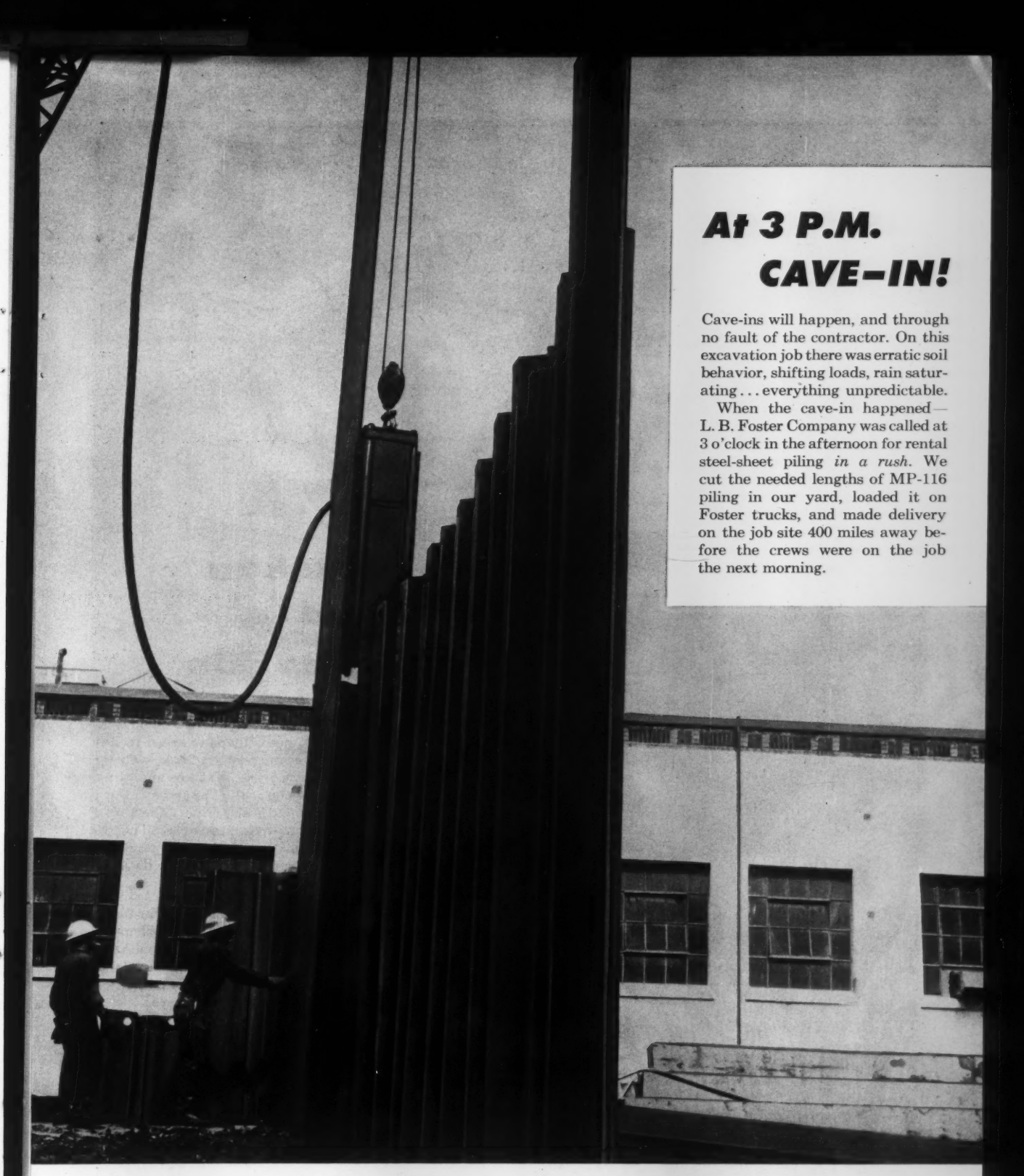
Applying Bitumuls to windrowed sand/clay material. *(Official United States Navy Photograph)*

The Bitumuls-stabilized sand/clay is spread, then compacted to specified density.

American Bitumuls & Asphalt Company

200 Bush St., San Francisco 20, Calif.
St. Louis 17, Mo. Cincinnati 38, Ohio Perth Amboy, N.J. Baltimore 3, Md.
Tucson, Ariz. Inglewood, Calif. Mobile, Ala. San Juan 23, P. R.
Oakland 1, Calif. Portland 7, Ore.

LEADING MARKETERS OF ASPHALTS, CUTBACKS AND BITUMULS – NATIONWIDE



At 3 P.M. CAVE-IN!

Cave-ins will happen, and through no fault of the contractor. On this excavation job there was erratic soil behavior, shifting loads, rain saturating . . . everything unpredictable.

When the cave-in happened—L. B. Foster Company was called at 3 o'clock in the afternoon for rental steel-sheet piling *in a rush*. We cut the needed lengths of MP-116 piling in our yard, loaded it on Foster trucks, and made delivery on the job site 400 miles away before the crews were on the job the next morning.

This is typical of the dependable help contractors all over the country can expect . . . and are getting . . . when they use the Foster Piling Rental Plan. Always the exact length and exact section . . . when you need it . . . on low fixed cost. Call or write your nearest Foster office for quotations on your temporary piling needs. Find out for yourself the real savings in renting from Foster.

"FASTER FROM FOSTER"

Steel-Sheet Piling, Pipe for Piling, H-Bearing Pile, Lightweight Piling—Rails, Pipe & Fabrication

L. B. FOSTER CO. PITTSBURGH 30, NEW YORK 7, CHICAGO 4, HOUSTON 2, ATLANTA 8, LOS ANGELES 5

muskeg and minerals

The Canadian wilderness, great treasure-house of new mineral resources, needs maps to speed its development. Treacherous muskeg . . . far below zero temperatures . . . remote areas . . . these and other problems make mapping difficult. The answer: Turn the job over to experienced AERO crews. These men are used to mapping in wilderness areas. They're equipped with the skills, the instruments and the know how to get complete, accurate map data for you efficiently, economically.

Mining and engineering companies find it far faster to turn over mapping and exploration problems to AERO and our affiliates. In Canada: CANADIAN AERO SERVICE LIMITED. When you're planning large scale mapping anywhere in the world, call on AERO—pioneer and leader in aerial surveys.

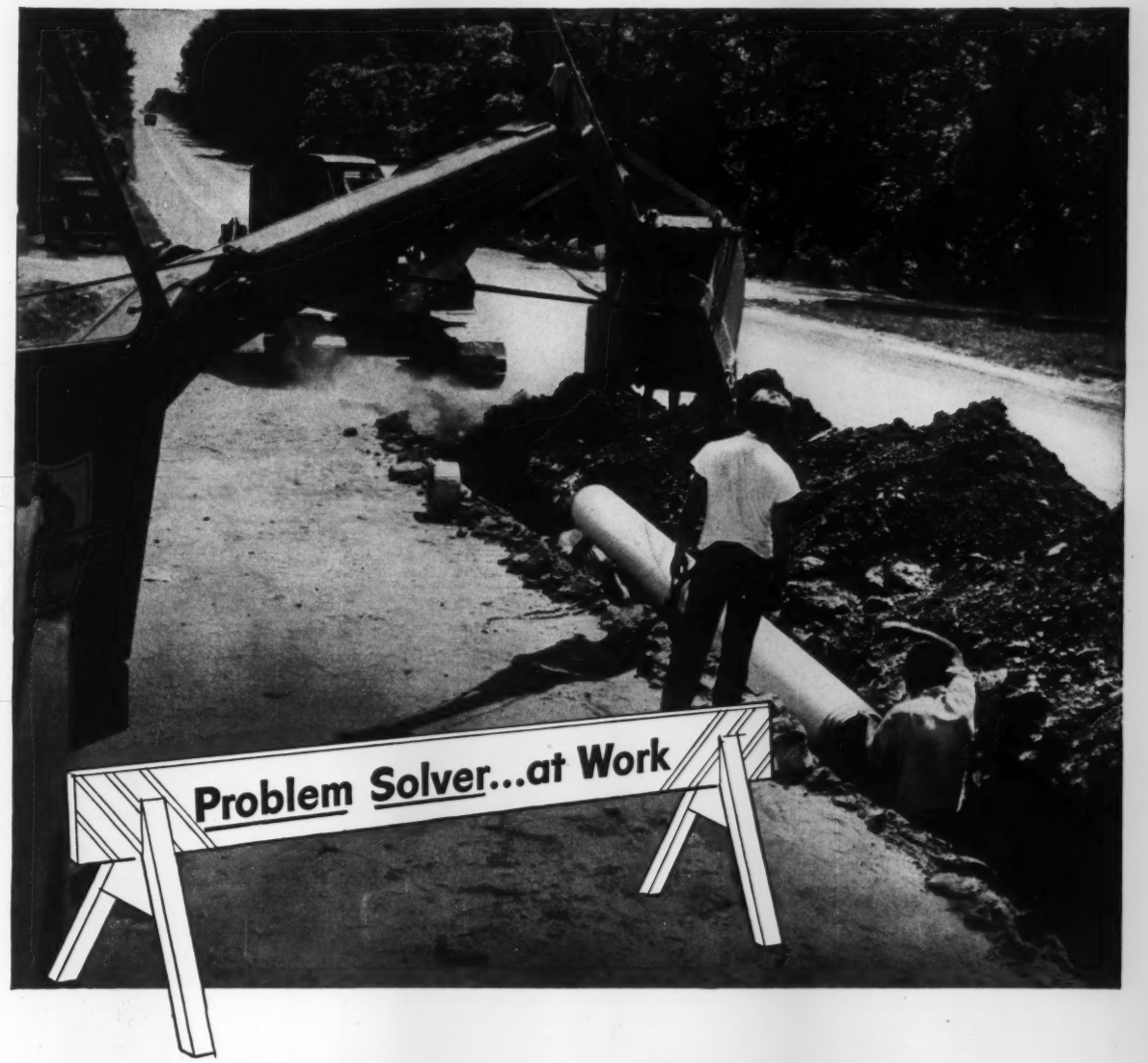
AERO SERVICE CORPORATION
PHILADELPHIA 20, PENNSYLVANIA

Oldest Flying Corporation in the World

Offices in **TULSA, DULUTH, SALT LAKE CITY, SAN FRANCISCO, JOHANNESBURG**

Our Canadian affiliate is: **CANADIAN AERO SERVICE LIMITED, OTTAWA**

AIRBORNE MAGNETOMETER SURVEYS
SCINTILLATION COUNTER SURVEYS
PRECISE AERIAL MOSAICS
TOPOGRAPHIC MAPS
PLANIMETRIC MAPS
RELIEF MODELS



Transite Pressure Pipe assures dependable service through the years

ENGINEERS and city officials face much the same problem in pipe selection. It is twofold: (1) How to make sure the community gets many long years of trouble-free performance from its pressure mains, and (2) How to do this as economically as possible by choosing pipe for durability plus savings.

Transite® Pressure Pipe is solving this problem in hundreds of municipalities and water districts from coast to coast. Here's why. An asbestos-cement product, strong and durable and highly resistant to corrosion, it has effected economies in installation as well as operation.

For example, the community benefits even at the very outset, since both handling and assembly of Transite Pressure Pipe are so simple that crews can install as fast as trench is opened. This means lower installed costs.

Another Transite Pipe characteristic instantly recognized by engineers as of major importance is its smooth interior that stays smooth. This provides maintained high flow capacity. (Flow coefficient is C-140.)

* * *

For further information about Transite Pressure Pipe with the Ring-Tite® Coupling, write for Booklet TR-160A. Address Johns-Manville, Box 60, New York 16, N. Y. In Canada, Port Credit, Ontario.

JOHNS-MANVILLE JM PRODUCT

Johns-Manville TRANSITE PRESSURE PIPE
WITH THE RING-TITE® COUPLING

ENGINEERING SOCIETIES

PERSONNEL SERVICE, INC.

NEW YORK	CHICAGO	DETROIT	SAN FRANCISCO
8 W. 40th ST.	84 E. RANDOLPH ST.	100 FARNSWORTH AVE.	57 POST ST.

This placement service is available to members of the Four Founder Societies. If placed as a result of these listings, the applicant agrees to pay a fee at rates listed by the service. These rates—established to maintain an efficient nonprofit personnel service—are available upon request. The same rule for payment of fees applies to registrants who advertise in these columns. All replies should be addressed to the key numbers indicated and mailed to the New York Office. Please enclose six cents in postage to cover cost of mailing and return of application. A weekly bulletin of engineering positions open is available to members of the cooperating societies at a subscription rate of $3.50 per quarter or $12 per annum, payable in advance.

Men Available

CIVIL-SANITARY ENGINEER; J. M. ASCE; AWWA; B.S.C.E.; 33; married; U.S. citizen; veteran; 7 years' varied experience, primarily with consulting engineer, involving design and construction of airfields, hydraulic structures, and municipal sanitary facilities. Interested in responsible position with consultant, contractor, or municipality. Commercial pilot's rating. Will relocate. C-133.

SANITARY ENGINEER; J.M. ASCE; B.S.S.E.; 35; married; 9 years' varied experience in sanitary engineering, with major portion of time in water supply, industrial waste, and pipeline-product design; water-treatment-plant design, construction, and operation; hydraulic design, including high-pressure applications. Location, preferred East or South. C-134.

CIVIL ENGINEER; A.M. ASCE; B.S.C.E.; M.S.C.E.; 36; 13 years' varied experience, design and construction of steel and concrete structures, highways, bridges, airports, and municipal facilities. Previous experience with private consulting firm and major oil company. Desires more responsible position; will consider foreign employment. Location desired, South, Midwest, or West. C-135-487-Chicago.

STRUCTURAL DESIGNER; J.M. ASCE; 27; B.S. and M.S. in C.E.; 6 months' experience as structural designer with midwestern boiler manufacturer (large stationary boilers). Location desired, West. C-136-488-Chicago.

HYDRAULIC ENGINEER

New York consulting firm has opening for an engineer with sound basic knowledge of hydraulic principles. At least 15 years experience desired, preferably in the general field of electric power production or water supply. Work includes:

1. **Office and field engineering for dams, spillways, flow lines and hydro-electric stations.**
2. **Hydrological studies of surface and ground-water supplies.**
3. **Field investigations of sites for steam electric and hydro-electric stations including preparation of preliminary economic comparisons.**

Write giving complete details of experience, education and personal data. Please submit complete resume to:

BOX 272

AMERICAN SOCIETY OF CIVIL ENGINEERS

33 W. 39th St., New York 18, N. Y.

Positions Available

ENGINEERS (*a*) Assistant Executive Director, degree in civil engineering, architecture, landscape engineering, landscape architecture, or city planning, with 6 years' experience in all principal phases of city planning, including at least 2 years' experience in supervision and administrative operations. Master's degree counts for one year's experience. Salary, $7,500 a year. (*b*) Director of Research and Public Information; (master's degree counts for one year's experience) with a minimum of 4 years' experience in city planning and government research, public information, and work with groups. Salary, $6,100 a year. Location, upstate New York. W-3226.

BITUMINOUS PAVING SCIENTIST to head up research program on well known new paving material. Finest laboratory facilities; excellent opportunity with international organization. Salary, first year, approximately $15,000. Location, Atlantic seaboard. W-3231.

FIELD ENGINEER, 30–40, with experience in sanitary and industrial construction for promotion of clay products; traveling in Virginia and North Carolina. Salary, $6,000 a year. W-3245.

ENGINEERS (*a*) Chief Engineer, graduate civil, with considerable experience in tunnel work, for large water supply tunnel. Salary, $15,000 a year. (*b*) Resident Engineer, with from 5 to 10 years' experience in tunnel work. Salary, $12,000 a year. Location, West. W-3247.

PERSONNEL MANAGER, about 35, with 3 to 5 years' administration, to handle all phases of personnel administration on the construction site. Salary, $7,800 a year, plus. Location, New York, N. Y. W-3262.

ENGINEERS (*a*) Chief Engineer, for public works department, with at least 3 years' experience in municipal sanitary, storm water and street design and layout. Salary, $7,100–$9,100 a year. (*b*) Civil Engineer, with a minimum of 2 years' general municipal engineering work. Salary, $5,500–$6,900 a year. Location, Connecticut. W-3271.

MUNICIPAL ENGINEER, civil graduate, with design and field engineering experience, covering drainage, sewers, highways, and municipal buildings. Salary, $6,000 a year. Location, Westchester County, New York. W-3275.

CITY PLANNER, master's degree in city planning, with at least 1 year's experience, or degree in planning, architecture or engineering, plus 3 years' experience preferably in master plan studies, or any equivalent combination of education and experience. Salary, $5,170 a year. Location, Connecticut. W-3284.

ENGINEERS (*a*) Structural Engineer, civil graduate, with at least 2 years' steel and concrete design experience on industrial and commercial buildings for office and field work. (*b*) Inspection Engineer, civil graduate, with at least 2 years' fabricated steel and reinforced concrete building construction experience. Some out-of-town trips. Salaries from $6,000 a year. Location, New York, N. Y., W-3288.

JUNIOR ENGINEERS, 20–30, graduate mechanical, civil, or electrical, for training program, in operating department of large gas pipeline company. No design or theoretical engineering. Salary, $4,800–$5,100 a year. Location, various in U.S. W-3300.

ENGINEERS FOR CONSULTING FIRM (*a*) Civil Engineer, with 5 to 10 years' experience in design and details of sewer and water systems, drainage and grading, street work, municipal engineering. Salary, $6,000–$8,000 a year, plus overtime and benefits. (*b*) Soils Engineer, with ability in civil or structural design engineering, to work on foundations of bridges, buildings, highway and miscellaneous structures, also testing and control of placement of earth fills for highway and railway project. Salary, $6,000–$8,000 a year, plus overtime and benefits. Location, Midwest. W-3313.

BRIDGE CONSTRUCTION SUPERINTENDENT, on the construction of a number of state highway bridges. Salary open. Location, New York, State. W-3315.

SALES ENGINEERS, young, to introduce outstanding product in sanitary and drainage fields. Salary open. Location, Gulf Coast. W-3333.

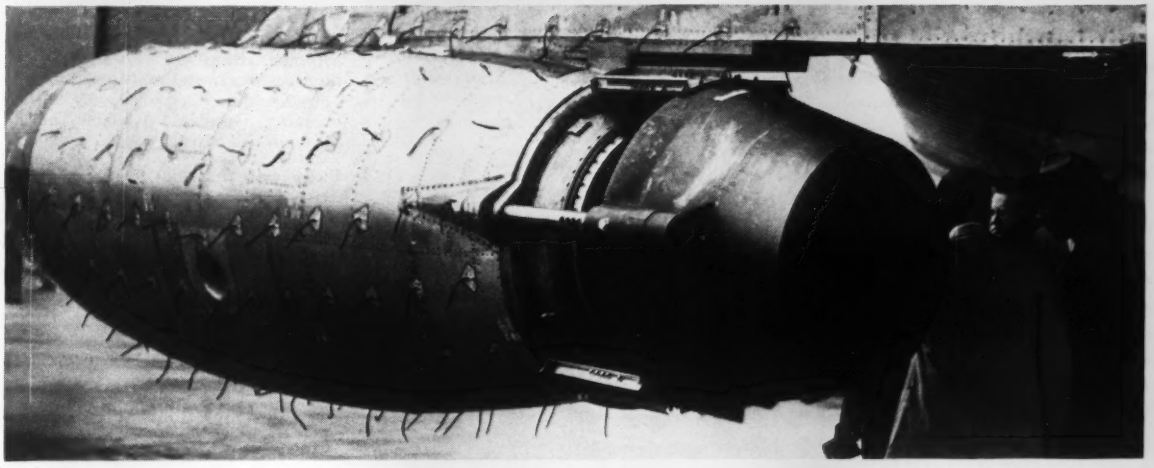
CIVIL ENGINEER, graduate, with 3 to 4 years' design and practical experience, to survey and lay out new streets, correct grade and alignment of existing streets, design storm drainage including curb and gutter and develop realistic programs for maintenance of existing paved and dirt streets. Location, Georgia. W-3335.

INSTRUCTOR-ASSISTANT PROFESSOR, with at least a B.S. in civil engineering, to teach surveying, photogrammetry, highway, and engineering mechanics including 4 weeks summer surveying camp. Salary, $6,000–$6,800 a year. Location, New York Metropolitan area. W-3356.

ENGINEERS (*a*) Design Draftsmen, with civil training, for design, layout, and detail of sewage-disposal plants and water supply systems. (*b*) Resident Engineer, with at least 5 years' supervisory, sanitary and water supply construction experience. Salary open. Location, New Jersey. W-3360.

HIGHWAY ENGINEER with 10 to 15 years supervisory experience on construction of highways and bridges. Salary open. Location, Colombia, South America. F-3375.

FIELD PROMOTION ENGINEER, to 45, degree, with at least 3 years' experience in soils, sewer work, or other contact with clays, to do field work, promoting the use of sewer pipe and other clay products. Some speaking, writing, and sales assistance work. Travel 50 percent of the time; car required. Salary, $7,200 a year. Headquarters, Chicago. C-4908.



Boeing "C.E.'s" help meet two pressing jet-age problems

Boeing civil engineers play an important part in designing such advanced devices as the prototype sound suppressor (top) and thrust reverser (bottom), shown installed on the Boeing 707. On production 707 jet airliners, however, the two will be combined into a single unit capable of performing the duties of both the suppressor and reverser. Test results have been so satisfactory that Boeing has contracted to deliver 707s to airlines, beginning in late 1958, equipped with sound suppressor-thrust reversers.

Civil engineers work closely with other engineers at Boeing in design and research for the 707, the KC-135 tanker-transport, the B-52 jet bomber, the BOMARC IM-99 weapons system, and aircraft of the future. Their work is challenging and creative, at the very frontiers of engineering knowledge in design, stress analysis, structural and flight testing, thermo and fluid dynamics, and in developing new uses for titanium, magnesium, plastics and other new materials.

Boeing now employs more than twice as many engineers as at the peak of World War II. But, because of steady expansion, more topnotch technical men are needed. They will work with superb facilities, including the multi-million-dollar new Boeing Flight Test Center, the latest electronic data reduction equipment, and a new wind tunnel, which will be in operation shortly, capable of velocities up to Mach 4.

Boeing engineers work in closely knit project teams. There are regular merit reviews, individual recognition and ample scope for creative expression. Engineering aides and draftsmen handle routine jobs, freeing engineers for the numerous stimulating assignments.

Life is pleasant for Boeing engineers and their families in the progressive, comfortable-size communities of Wichita and Seattle. How would you like to do interesting and vital work with one of the world's leaders in aviation? Inquire now about an opening on one of Boeing's research, design or production teams.

JOHN C. SANDERS, Staff Engineer — Personnel
Boeing Airplane Co., Dept. D-52, Seattle 14, Wash.

R. J. B. HOFFMAN, Administrative Engineer
Boeing Airplane Co., Dept. D-52, Wichita, Kansas

If you want further information on the advantages of a career with Boeing, please send coupon to either of the above addresses.

Name_____

College(s)_____ Degree(s)___ Year(s)___

Address_____

City_____ Zone___ State_____

Telephone number_____

BOEING

Aviation leadership since 1916

SEATTLE, WASHINGTON WICHITA, KANSAS

AIRCRAFT ENGINEERS
With Experience
WANTED AT
GRUMMAN

LAYOUT DESIGNERS
Airframe Structures

FLIGHT TESTING
Planners
Analysts

HYDRAULICS
Systems Design
Testing

STRUCTURES
Stress Analysis

RESEARCH
Computer Engrs. Digital or Analog
Vibration & Flutter Engrs.
Dynamic Analysis—Systems Engineers

ARMAMENT INSTALLATION
AERODYNAMICS
INSTRUMENTATION

TOOL DESIGNERS

Recent Graduates with Aeronautical, Mechanical, Civil or Engineering Physics Degrees may qualify.

Proof of U. S. Citizenship Required

APPLY IN PERSON
OR SEND RESUME TO:
Engineering Personnel Dept.

INTERVIEWS AT
Employment Office
South Oyster Bay Road
North of Railroad

Monday thru Friday
8:30–11:30 AM; 1:30–3:30 PM

GRUMMAN AIRCRAFT
Engineering Corp.
Bethpage, N. Y.

Applications for Admission

(*Continued from page 116*)

GERARD DUNCAN GALLETLY, Emeryville, Calif.
MANLEY ELDON GREEN, Kansas City, Mo.
ALBERT HOMEWOOD GRISWOLD, University Heights, N. Y.
RAYMOND HANSEN, Vicksburg, Miss.
RICHARD HAROLD HENRY, Spokane, Wash.
ROY HENRY HOFFMAN, San Francisco, Calif.
MOHAMMAD AMINUL HUQ, Albany, N. Y.
ALTAF HUSSAIN, Fort Belvoir, Va.
MAX ISRAEL, Los Angeles, Calif.
CHARLES WILLIAM JORGENSEN, JR., New York, N. Y.
IVADURAI KASIRAJ, Boston, Mass.
WILLIARD CONRAD KREGGER, McCook, Nebr.
JOAKIM GEORGE LAGUROS, Ames, Iowa.
GORDON WALTER LUDWIG, El Monte, Calif.
ROBERT LOREN LONGARDNER, Indianapolis, Ind.
ANTHONY AUGUSTINE MCLOUGHLIN, Providence, R. I.
RICHARD CHARLES MCNAMARA, St. Paul, Minn.
DONALD EUGENE METZLER, Iowa City, Iowa.
DONALD ARTHUR MOG, Milwaukee, Wis.
DAMODARAN ASAN APPUKUTTAN NAIR, Ann Arbor, Mich.
CLARANCE ADRIAN NELSON, Chicago, Ill.
JOSEPH EARL NEWBERRY, Savannah, Ga.
NIKOLAOS PANAYOTIS PORTOKALIS, New York, N. Y.
JAMES WALTER ROBBINS, Baltimore, Md.
JOHN JAMES ROUMAN, Appleton, Wis.
ARTHUR WILLIAM SCHULZ, Jacksonville, Fla.
CHARLES LAMBERT SCHUSTER, Honolulu, Hawaii.
LOUIS PAUL SCHWENDEMAN, Pittsburgh, Pa.
ERNEST ARTHUR SHERMAN, Meriden, Conn.
JULIUS WEI-WU SHIE, New York, N. Y.
EUGENE RICHARD SHULZE, Rolla, Mo.
WILLIAM PETER SIMMONS, JR., Denver, Colo.
HERBERT HARRY SPENCER, New Haven, Conn.
JOHN RALPH STALLINGS, JR., Topeka, Kans.
CHARLES INGRAM STANTON, JR., Dallas, Tex.
WALTER STARK, Seattle, Wash.
EDWARD FRANCIS STEVENS, JR., Seattle, Wash.
JACK DARWIN STINE, San Bernardino, Calif.
VERNON EDWARD SWANSON, New York, N. Y.
JOHN MILES SWEENEY, Pittsburgh, Pa.
ROBERT TALMAN, Lincolnwood, Ill.
STAVROS THEMISTOCLES TSAKONAS, New York, N. Y.
ARVIDS OLGERTS UPESLEJA, Olympia, Wash.
ALAN MANNERS VOORHEES, Washington, D. C.
HANS OTTO WEDEKIND, Karachi, Pakistan.
THOMAS HARRISON WINCHESTER, JR., Macon, Ga.

Applying for Affiliate

GEORGE DEGRUCHY FOX, Ruxton, Md.

Applying for Junior Member

CARLIE BOWMER, Louisville, Ky.
ROBERT SKEEN BRADEN, Houston, Tex.
WILLIAM RICHARD BRAZILL, New York, N. Y.
JORGE MARIO CHAVEZ, Salt Lake City, Utah.
DAVID AARON CRANE, Bishop, Calif.
JOAO PAULO MENDES PENNA DE CARVALHO, Cambridge, Mass.
EDWARD MALDWYN ENVART, Toledo, Ohio.
UGUR ERSOY, Austin, Tex.
JAMES WALLACE FEHR, Louisville, Ky.
JAMES FRANCOMACARO, China Lake, Calif.
THOMAS AUGUSTUS FRIDY, JR., Spartanburg, S. C.
RUSSELL MELBOURNE GARRARD, St. Ignace, Mich.
RALPH EBERHART GRUENBERG, Kansas City, Mo.
GERMAN RUBEN GURFINKEL-GREENSTEIN, Urbana, Ill.
CHARLES WILLIAM HETZER, JR., Hagerstown, Md.
WILLIAM MARTIN HOLMBERG, JR., St. Louis, Mo.
ROBERT MICHAEL KOSCIELNY, Fort Bliss, Tex.
SIDNEY WILKES LESIEUR, Salt Lake City, Utah.
MAHENDRA JAJ MEHNDIRATTA, Minneapolis, Minn.
GERALD FRANCIS PAULSON, Minneapolis, Minn.
BEN MCDOWELL PETITT, JR., San Antonio, Tex.
DONALD VAN NORMAN ROBERTS, Los Angeles, Calif.
GILMORE ADAM ROSE, Olympia, Wash.
LLOYD ALLAN ROWE, Sask, Canada.
WERNER EDWARD SCHMID, Easton, Pa.
DAVID WOMBLE SHARPE, Newark, Del.
OMAR JOSEPH SOTILLO, Troy, N. Y.
KUPPUSWAMY SRINIVASAN, Tucson, Ariz.
RAYMOND IOAN THERON, Columbia, Mo.
BERNARD LYNN TILAND, Portland, Ore.
MELVIN RAY TRAYLOR, Dallas, Tex.
SHIU-FOO TSOI, London, England.
GEORGE ALAN URMSTON, Montreal, Canada.
MARVIN CLARK WALLINGFORD, Tacoma, Wash.
CARL ZILLIG, Cincinnati, Ohio.

[Applications for Junior Memberships from ASCE Student Chapters are not listed.]

STRUCTURAL
ENGINEERS
DESIGNERS
DRAFTSMEN

Prefer several years' experience in bridges, buildings, highway structures or hydro structures. Will consider lesser experience with good educational background.

We are professional engineers and desire men who wish long range employment with good opportunity to advance and develop in professional engineering. Occasional openings in construction supervision and inspection.

Paid vacation, sick leave, holidays, overtime. Employee Benefits Plan furnishes retirement income and insurance. Blue Cross. Moving allowance. Openings available in St. Louis and San Francisco.

Please write fully to

SVERDRUP & PARCEL, INC.
Engineers — Architects
915 Olive St. Louis 1, Mo.

SYNTAC

SYNTAC, of Synthetic Tactics, is a dynamic, two-sided map maneuver with controlled intelligence flow. It is one of several tools of analysis used by the Combat Operations Research Group to develop new combat organizations and tactics for the Army.

Physicists and applied mathematicians can make substantial contributions to long range CORG operations research efforts. Staff appointments are available for individuals with various levels of training and experience.

Write for brochure:
Dr. F. C. Brooks, Director, CORG
Fort Monroe, Va.

TECHNICAL OPERATIONS, Inc.

WANTED! ENGINEERS TO HELP MAKE LONG RANGE MISSILE HISTORY

North American's Missile Projects Offer A New Engineering Adventure

With complete weapons system responsibility for the SM-64 NAVAHO Intercontinental Guided Missile, North American is engaged in one of the most challenging programs yet offered. But every inch of progress is a tough scientific battle. New means are daily being found to solve the complex problems which the development of long range missiles presents in the fields of structures, temperatures and aerodynamics. But most important of all, *men* must be found who thrive on this kind of challenge . . . men who are really excited about this new missile science. Are you one of them?

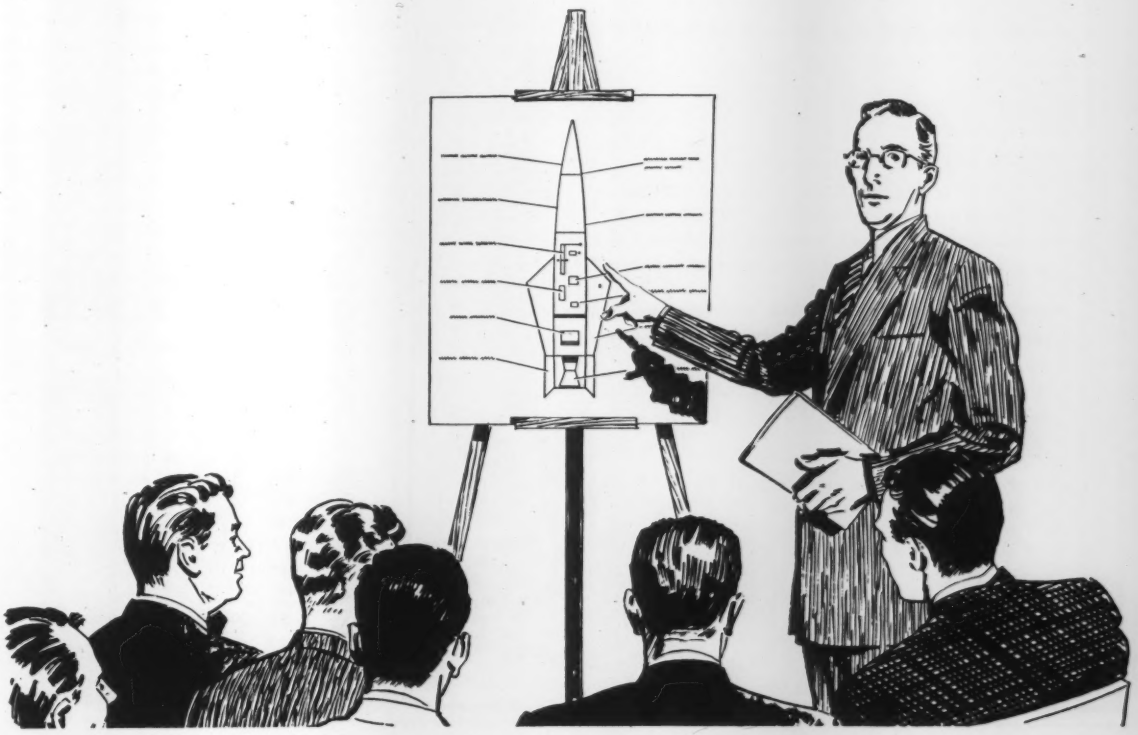
If you qualify in one of the fields we have listed below, chances are you can qualify for this unique expedition into the technology of the future. We would like to tell you about all the physical and professional advantages of a career in North American's Missile Development Engineering.

Please contact us for the full story:

Instrumentation Design, Development & Application **Standards, Drawings Checking, Specifications Writing**
Structures, Stress, Flutter and Aeroelasticity **Component and System Reliability Engineering** **Thermodynamics**
Missile Airframe Design **Hydraulic, Pneumatic & Servo Engineering** **Armament Systems & Components Engineering**
Aerodynamics **Engineering Flight Test** **High Temperature Materials Engineering** **Mechanical & Electrical Design**

Contact: R. L. Cunningham, Missile Engineering Personnel Office
Dept. 91-20CIV, 12214 Lakewood Boulevard, Downey, Calif.

NORTH AMERICAN AVIATION, INC.

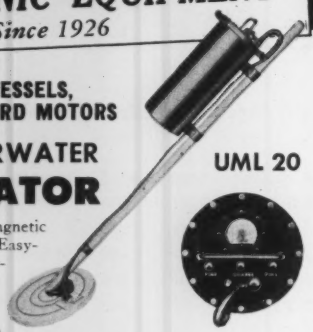


SUPERSENSITIVE ELECTRONIC EQUIPMENT

Since 1926

SALVAGE SUNKEN VESSELS, CABLES, PIPES, OUTBOARD MOTORS

NEW **... UNDERWATER METAL LOCATOR**



UML 20

Pinpoints ferrous and non-magnetic metals in fresh or salt water. Easy-to-read "MEMETER" in water-tight, non-corroding housing. Withstands depths to 160 feet. Supersensitive amplifier. Weighs only 1¾ lbs. submerged. For professional and amateur divers. $545 net, including batteries, immediate delivery.

UPD-3 SELF-PROPELLED "POWER DIVER"

Conserves energy and air supply underwater. About one hour continuous operation. Descend, ascend, roll or turn, finger tip control, depths to 200 feet. Pressurized fibre-glass, weighs less than ½ lb. submerged. $350, rechargeable 6-volt battery extra.

COMMUNICATOR RADIOTELEPHONE BRT 1025

Ship-to-Shore telephone. 4 channels plus tunable broadcast receiver. Talk with other vessels or call Coast Guard in an emergency. Now only $295 including all crystals.

Higher power models available.

Other Precision-Built Products

GPL UNDERWATER TELEVISION CAMERA • DEPTH RECORDERS • RADAR

Brochures mailed on request *All Prices F.O.B. New York*

BLUDWORTH MARINE

DIVISION OF KEARFOTT COMPANY, INC.

92 Gold Street, New York 38, N. Y.

CIVIL ENGINEERS

(AGES 25-32)

Career opportunities for civil engineers in the expanding organization of a major U.S. integrated oil company operating in South America. Openings available in positions requiring 4½ to 6 years experience in (1) highway engineering and maintenance, asphalt mixes and subgrade design; (2) structural design, including foundations for large structures and a background in soil mechanics; (3) concrete studies and research; (4) general civil engineering functions relating to utilities, buildings, bridges, harbor bulkheads, tanker piers, etc. Salary, including bonus, $14,000. Liberal employes benefits and home vacations with travel expenses. Send complete resume of work experience and personal data. Interviews will be arranged for qualified candidates. All replies confidential.

Box 1221
Dept. K-78
New York 1, N. Y.

CONCRETE ENGINEER

Are you a graduate civil engineer with ten years experience in the practical solution of concrete construction problems?

Would you like to be general concrete supervisor for a leading engineering and construction company serving the petroleum, chemical, ore-processing and power industries? You'd live and work in sunny Southern California, with occasional travel to field projects in this country and abroad.

To fill this responsible position you must be familiar with all phases of the concrete industry. You must have a thorough working knowledge of the latest practice in concrete construction, including mix design, mixing and handling, form design, placement, and the organization of large concrete operations.

Your inquiry will be confidential. Please write to the head of our Personnel Department, Mr F B Stratford.

C F Braun & Co

ALHAMBRA CALIFORNIA

ESTABLISHED 1909

Structural architectural engineer with steam electric and hydro-electric power plant experience to supervise structural steel design, prepare specifications, inquiries and purchase requisitions. Experience in other fields of engineering desirable.

STRUCTURAL ENGINEER

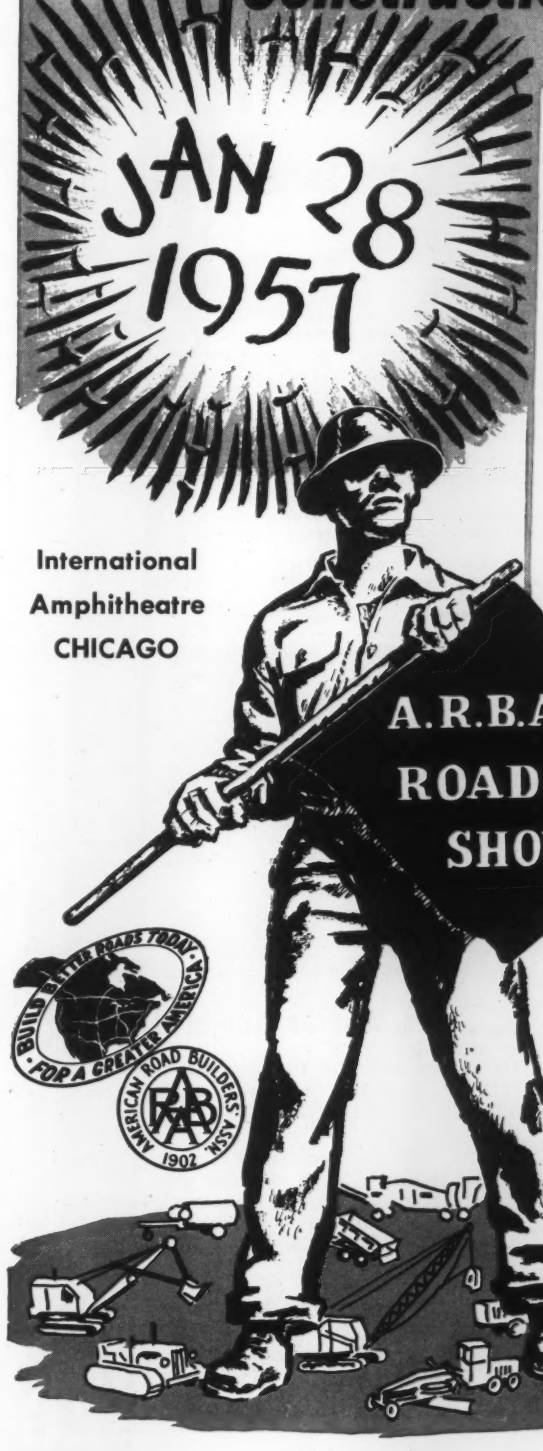
Position with large New York engineering and construction firm. Regular staff position with liberal company benefits. Salary commensurate with experience. Excellent opportunity for future advancement.

Please submit complete resume to:

Box 273

American Society of Civil Engineers
33 W. 39th St. New York 18, N. Y.

The most important date for the Construction Industry in 1957



International
Amphitheatre
CHICAGO

A.R.B.A.
ROAD SHOW and CONVENTION
PLAN NOW!

1957 will bring with it the first Road Show in almost 10 years! Tremendous advancements have been made in this last decade. New equipment has been developed. New methods have superseded old. New cost-cutting ideas have come forward. Here is the time and place to bring yourself up to date on all the new developments.

Nothing is being spared to make this 1957 Road Show the greatest indoor exhibit of machinery and materials ever gathered together. At the same time, the A.R.B.A. convention will give you an opportunity to learn about new methods and practices and hear outstanding authorities discuss the solution of problems that are bothering you.

Put it down as the most important date for the construction industry in 1957. Write for data on reservations. Ask to be put on the list to receive future information on the 1957 A.R.B.A. Road Show and Convention.

AMERICAN ROAD BUILDERS' ASSOCIATION
World Center Building
Washington 6, D.C.

16 MILLION GALLONS OF WATER PER DAY, even in extremely dry periods

Says

Mr. R. E. Cannard
Manager, City of Manitowoc
Public Utilities

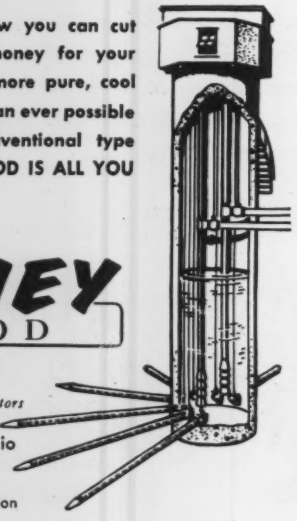
the RANNEY METHOD a "MUST" for the CITY OF MANITOWOC, WISCONSIN

Collector "A" at the Power Plant, City of Manitowoc

Mr. Cannard says, "We have found the RANNEY to be far more efficient than the conventional type wells. Our RANNEY collectors require less personnel, fewer pumps, cuts operating costs, and eliminates filter stations altogether. The RANNEY METHOD has solved our water problems and the collectors are just as good today as they were when they were installed ten years ago."

FOR YOUR CITY TOO

Write now, and learn how you can cut unnecessary costs, save money for your community, and produce more pure, cool water from just one well than ever possible before, with multiple conventional type wells. THE RANNEY METHOD IS ALL YOU NEED.



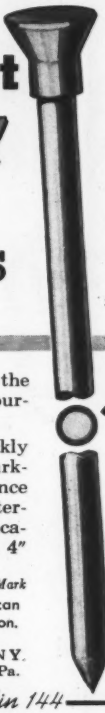
RANNEY METHOD

Water Supplies, Inc.
Water Supply Engineers and Contractors

841 Alton, Columbus 19, Ohio
CE-1
Associate:
Ranney Method Western Corporation

Save with **Permanent** Copperweld TRADE MARK **MARKERS**

ADAPTER FITS FLUSH WITH MARKER



Can't Rust! thick copper covering molten welded to steel core

- PROTECT your investment in the original survey—and protect yourself from troublesome disputes.
- AT LITTLE COST you can quickly and easily drive Copperweld* Markers and have permanent reference points. Bronze head can be center-punched and stamped for identification. If larger head is needed, a 4" adapter is available.

*Trade Mark

Standard length is 3 feet—other sizes can be furnished. Packed 10 markers to a carton.

COPPERWELD STEEL COMPANY
WIRE AND CABLE DIVISION Glassport, Pa.

Write for Bulletin 144

10 DAY FREE TRIAL

. . . of a Warren-Knight Transit!

Try a Warren-Knight Transit on your own work FREE for 10 days! Then you'll see for yourself how special advantages of these famous instruments save time and money. Model 2cF for instance, has disappearing stadia, graduations differentiated by BOTH size and slant, and replaceable leveling screws. To obtain full information on many other extra advantages, write for FREE information CE-66 with full details.

WARREN-KNIGHT
136 NORTH 12TH STREET PHILADELPHIA 7, PA.

Imperial

the world's finest

TRACING CLOTH

In drafting rooms throughout the world Imperial quality is the standard by which fine tracing cloths are judged. This has been true for decades, and Imperial remains the finest tracing cloth because its makers have continued to improve its quality and value.

MAYO

PNEUMATIC GROUTER and "PEA SHOOTER"

The Mayo Pneumatic Grouter has performed capably on jobs ranging from tunnels, mines, and shafts to foundations and railroad subgrades. Simple and efficient in operation, it may also be used for injecting chemical soil stabilizers into caving or running ground. For grouting back of lagging in rock tunnels or back of liner plates in soft ground, the Mayo Grouter is readily converted to a "Pea Shooter" for shooting Pea or "Bird's Eye" gravel. The Mayo Pneumatic Grouter has no moving parts within the Grout . . . gives years of trouble-free service. Shop tested to twice working pressure. Capacity: 3½ cu. ft., charging height: 3 ft.

For complete details and specifications, write for Free Bulletin 13

MAYO

TUNNEL & MINE EQUIPMENT

LANCASTER, PA.

Steel Forms
Headframes
Muck Bins
Shields+Air Locks
Locomotives
Mine Cars
Grouters

Riveted Grating in Power House
RIV-DEXTEEL Bridge Decking
Welded Grating Platform
Welded Grating Ventilating Grates
HEXTEEL Heavy Duty Steel Floor Armor in concrete
HEXTEEL installed as Retainer for Canister Liner
Riveted Grating Catwalk
Welded Grating in Filtration Plant
FLOORSTEEL Flexible Steel Floor Armor
Riveted Grating Mezzanine

"KLEMP GRATING and STEEL FLOOR ARMORS"

CUT CONSTRUCTION AND BUILDING COSTS FROM THE START!

- OPEN STEEL FLOORING
- HEXTEEL
- FLOORSTEEL
- STAIR TREADS
- RIV-DEXTEEL BRIDGE DECKING

. . . are world-famous Klemp products that "do the job" and eliminate future maintenance costs. Our engineering department will design installations to your requirements. Our plant will fabricate to your specifications in ferrous and non-ferrous metals at the least possible cost! Speedy delivery guaranteed!

KLEMP METAL GRATING CORPORATION

PLANT AND GENERAL OFFICE 6601 South Melvina Avenue Chicago 38 Illinois POrtsmouth 7-6760

Send us data or a dimensional sketch today! We will reply with recommendations and price estimate for your job!

CE

KLEMP METAL GRATING CORPORATION
6601 South Melvina Avenue, Chicago 38, Ill

Gentlemen:
Kindly send me a copy of your "Data and Specification Manual."

Name_____
Firm_____
Address_____
City_____ Zone____ State_____
Phone_____

EQUIPMENT, MATERIALS and METHODS

NEW DEVELOPMENTS OF INTEREST AS REPORTED BY MANUFACTURERS

More Power And New Off-Highway Equipment Mark International's New Line

INTERNATIONAL HARVESTER'S NEW CONSTRUCTION EQUIPMENT DIVISION is taking dead-aim on the anticipated boom in the construction market. Added to their line of construction equipment are two new off-highway rear-dump trucks—Models 65 and 95 Payhaulers—and the new, crawler mounted Payloader. Drawbar horsepower has been stepped up in the tractor line on the TD 6, 9, 14, and 18. The Payscrapers have also been redesigned to step up capacity with a rated heaped loading of 20 cu yd for the Model 75 and 14 cu yd for the Model 55. The International line now includes 7 models of crawler tractor, 18 power units, 3 sizes of four-wheeled scrapers, 2 self-propelled scrapers, 2 off-highway trucks, a self-propelled bottom-dump wagon, 5 International Drott Skid Shovels, and the new crawler, rear-engine Payloader. Most striking feature of the new line is the two new off-highway trucks. The 24-ton Model 95, 16 cu yd Payhauler is powered with a Cummins Turbo-charged diesel engine developing 335 bhp at 2100 rpm. It has a top speed of 38 mph when powered with a torque converter and power-shift transmission according to the manufacturer. The Model 65 with a 16-ton capacity is equipped with either a 5 or 10 speed transmission with an air assisted clutch, and develops 250 bhp at 2100 rpm. Its top speed is rated at 36½ mph.

Stepping ahead in the loader field, International has come up with its new Model 12 Payloader. Unique features of this tractor-shovel are the rear-mounted engine and the crawler tracks which are quite a departure from the conventional tractor with the front-end bucket attachment, or the rubber-tired front-end loaders of the well known Hough series. This new Payloader has a top forward speed of 10 mph and a top reverse speed of 13 mph. It is powered with an International UD-350 diesel rated at 91½ hp. The bucket has a 1¾ cu yd capacity and a discharge height of 8 ft 10 in. It is equipped with full power shift transmission and torque converter drive. The whole body can be tilted up for easy access in servicing the rear deck of the main frame, an asset to maintenance minded contractors.

The tractor line of IH has also come in for some overhauling. Biggest feature from the TD 18 on down to the TD 6 is the stepped up power. The TD 18 with a 6 cylinder diesel engine is now rated at 103 drawbar hp. The 78.5 drawbar hp of the TD 14 represents an increase of 12½ percent while the TD 9 is up 32 percent with a dbhp of 54.5 and the dbhp of the TD 6 has been boosted from 33.7 to 41.5.

Driver comfort has been stressed throughout the entire line of tractors and trucks on the theory that equipment output is directly proportional to the operators' comfort. Conveniences range from adjustable foam rubber seats to an attachment for an electric razor. Particular attention has been paid to the position of the driver with regard to visibility which not only results in increased efficiency but is an added safety factor. **International Harvester Company, CE 6-130, 180 North Michigan Ave., Chicago 1, Ill.**

Model 12 Payloader

Model 95 Payhauler

Drawing Instrument

A NEW DRAWING INSTRUMENT combines twelve basic features into one precision instrument. Each of the several different calibrated edges is as accurate as the finest ruler. It is the only instrument with which successive parallel lines can be drawn equally spaced. In addition to a ⅛-in., ¼-in. scale and 12-in. ruler, the instrument contains a double calibrated 180-deg adjustable protractor, ¼-in. pointer, templates, french curves, common symbols and the advantages of squares and straight edges. The complete tool, made of fine tinted syrene plastic, measures 8½-in. by 12-in. **Handee-Dandee Products, Inc., CE 6-131, 3019 Pico Blvd., Santa Monica 8, Calif.**

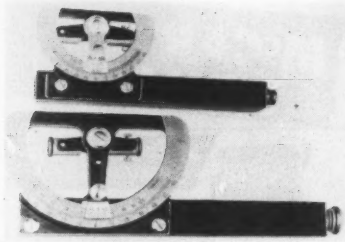
Fibre Forms

A NEW PLASTIC LINED FIBRE FORM called Deltube for round concrete columns is being introduced. Deltube forms have been engineered with a special plastic lining, making it an important advance in fibre forms. The plastic lining releases immediately, does not adhere, and leaves a smooth dustless finish on the column. The body of the tube is constructed of plys of long jute fibre kraft. All plys are bonded with waterproof adhesive in addition to which the outer ply is asphalt saturated. The result is one of the strongest, most rigid, and water resistant fibre tubes offered today. **The Delta Company, CE 6-130, 333 West 24th Place, Chicago 16, Ill.**

Vellum

AN IMPROVED TRACING VELLUM called Blutex erases cleaner and faster. Chief reason for the easier erasing qualities is a new combination of transparentizing materials used in treating the base stock. Blutex is treated with 100% synthetic resins rather than oils. The resins provide a drier working surface of unchanging characteristics. While dry, the paper is never brittle.

The dry surface of Blutex takes opaque graphite lines with unusual ease and uniformity, and it is just as erasable after aging or repeated reproductions as it is when first used. **Frederick Post Company, CE 6-130, 3666 North Avondale Ave., Chicago 18, Ill.**



GEO-HANDLEVELS

For fast and accurate work in general leveling, heights measuring, topographic mapping. Mines, Highways. Precision controlled index arms gives accurate.

No. 31C	Abney Reflecting Level, small type, fixed eyepiece in pigskin case (Top Illustration)	$22.00
No. 31A	Abney Reflecting Level, large type (pocket altimeter) percent and degrees in pigskin case (Bottom Illustration)	$26.00
No. 33A	5 inch-locke hand level with lens, in pigskin case	$ 7.50
No. 33B	5¼ inch square hand level with fixed eyepiece, Stadia hair 1:100, in pigskin case	$ 5.00
No. 31B	Abney Reflecting Level, large type (Interchangeable 2 scales) in pigskin case	$26.00
No. 48	Pocket Transit	$40.00
No. 123	Compensation Planimeter	$28.00

HIGHEST QUALITY!

10 days trial!

For more information write to:

GEO-OPTIC COMPANY, INC.
170 Broadway, New York 38, N.Y.

DEALERSHIP AVAILABLE ! ! !

Nearly 50 years of World wide experience. Modern equipment. Trained crews.

Foundation
TEST BORINGS
★
An Engineering Service
For Engineers
By Engineers

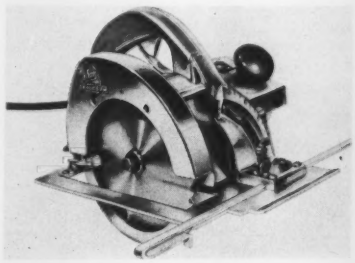
PENNSYLVANIA Drilling CO.
DRILLING CONTRACTORS
PITTSBURGH 20, PA.

EQUIPMENT MATERIALS and METHODS

(continued)

Electric Saw

A PORTABLE ELECTRIC SAW, driven by a universal motor that delivers a 1¾ hp, is designated as the No. 475 Speedsaw. A heavy-duty unit, its chief protective features are the automatically telescoping blade guard and a streamlined handle permitting safe withdrawal of the guard for plunge cuts.



No. 475 Speedsaw

The new model meets all standard requirements for sawing in its blade range including quick wing-nut adjustments for depth of cut and for angle cuts to 45 deg. There is a heavy-duty protractor for positive and accurate angle cuts, a cutting guide-notch to assure accuracy of cuts and a rip guide.

Housed in aluminum alloy die castings, the new Speedsaw operates on either a-c or d-c current. It develops 5400 rpm at full no-load speed. The tool cuts to a maximum depth of $2^{7}/_{16}$-in. and a minimum of $^{1}/_{8}$-in. **Thor Power Tool Company, CE 6-131, Aurora, Ill.**

Porcelain-Faced Plywood Panel

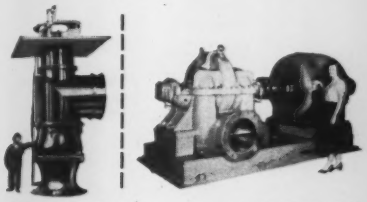
A NEW PORCELAIN-FACED PLYWOOD PANEL, ideal for a score of both industrial and home uses, exterior and interior, is being introduced to the construction and modernization markets. Less expensive than many materials of its kind, its low cost is the result of mass production methods made possible by standardization of the panel size and colors. All the panels come 36 by 96-in. and $^{5}/_{16}$ of an inch thick, with nine shades of colors included in the line.

Called Porc-Lin-Ply, the panel porcelain facing is reinforced with a laminated exterior plywood core and backed with a metal sheet, assuring minimum distortion. Not only will the panel resist moisture but in addition is resistant to oil, acids, smoke and solvents. It is easily cleaned with a damp cloth. **United States Plywood Corporation, CE 6-131, 55 West 44th St., New York 36, N. Y.**

YOU NAME THE PURPOSE WE MAKE THE PUMP

For every specific need from the smallest to the giants of 200,000 GPM capacity — Highly specialized engineering and manufacturing for over 40 years assures freedom from maintenance worries — Many users report 15 to 20 years service without replacement of major parts.

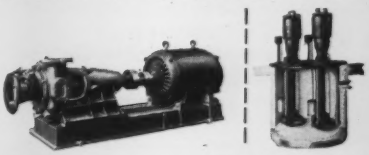
WHEELER-ECONOMY PUMPS



VERTICAL AXIAL FLOW FOR CIRCULATING CONDENSER COOLING WATER

DUAL VOLUTE FOR MUNICIPAL WATER WORKS

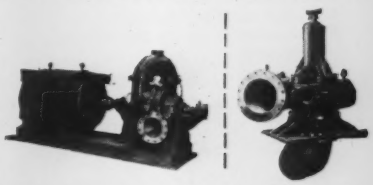
WHEELER-ECONOMY PUMPS



HORIZONTAL NON-CLOG FOR SEWAGE, TRASH, STOCK

DUPLEX, SUBMERGED NON-CLOG FOR SANITATION SEWAGE, INDUSTRIAL WASTE

WHEELER-ECONOMY PUMPS



TWO-STAGE DMD HIGH HEAD FOR MUNICIPAL & INDUSTRIAL SERVICE

VERTICAL MIXED FLOW FOR IRRIGATION, DRAINAGE, FLOOD CONTROL, SEWAGE

WE-500

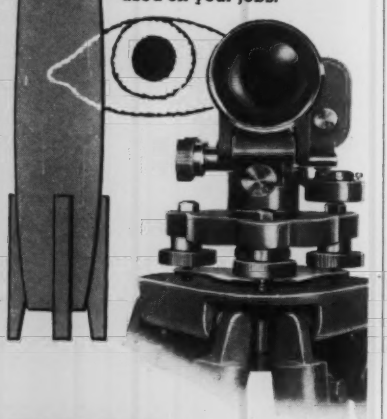
ECONOMY-PUMPS, INC.
Division of
C. H. WHEELER MANUFACTURING CO.

ECONOMY PUMPS, INC. • DIVISION OF C. H. WHEELER MANUFACTURING CO. 19TH AND LEHIGH, PHILADELPHIA 32, PA.

You're Not Behind
The Times
IF You're Behind a

KERN INSTRUMENT

Obsolete surveying tools are time-consuming, wasteful ... out of step with modern construction equipment used on your jobs.



KERN THE MOST MODERN surveying instruments available. Down-to-fundamentals, functional design ... maximum operational efficiency and portability ... reliable precision results.

KNOWN THE WORLD OVER
for accuracy, speed, reliability, economy.

- **Minimum set-up time**
- **Fast, effortless, simple operation**
- **Readings at a glance**
- **Exceptional clarity and contrast of image**

★

For Full Information Write for Brochure V 554-2

PROMPT, RELIABLE SERVICE
FACTORY TRAINED PERSONNEL

Kern and Only Kern
Offers You
The Latest Designs of
Dr. Henry WILD

Kern SWISS
The FINEST in SURVEYING EQUIPMENT
KERN INSTRUMENTS INC.
120 Grand St., White Plains, N.Y.

EQUIPMENT MATERIALS and METHODS

(continued)

Barrel-Shaped Tires

THE TERRA-TIRE, a barrel-shaped, low-pressure pneumatic tire that can be powered through its axle by any conventional drive system, has been announced. The Terra-Tire can take trucks, trailers and other off-the-road vehicles over all types of terrain and roadways. Speeds up to 65-mph can be achieved.

Through a hub and axle fitting, the tire receives its motive power directly from the engine. This tie-in with conventional drive systems means considerable savings

Travels Anywhere

in weight, mechanical complication and cost. Acting as a built-in shock absorber, the tire can sustain heavy loads because weight is spread over wide areas of it. Low ground bearing pressure and the large footprint of the tire makes it possible for vehicles to roll over any terrain without rutting. **The Goodyear Tire & Rubber Company, CE 6-132, Aviation Products Division, Akron 16, Ohio.**

Pressure Transmitter

MEASURING PRESSURES IN RANGES as low as 0 to 5-mm Mercury Absolute, a new pressure transmitter will transmit the measurement as a 3–15 psi pneumatic signal to an automatic controller or receiver. The Metagraphic absolute pressure transmitter is offered to handle pressure ranges from 1–5 mm Hg to 0–760 mm Hg. It transmits a universal 3–15 psi pneumatic signal, and can be used with any standard pneumatic receiver or automatic controller. **The Bristol Company, CE 6-132, Waterbury, Conn.**

Gate Valve

DESIGNED TO MEET THE SPECIALIZED NEEDS of water companies, a new low cost valve has a cast iron body and bronze-mounted type gate valve with a non-rising stem. Screw type valves with standard 8-V thread are available from $2^1/_2$-in. to 8-in. pipe sizes, and flange type valves with standard face and drilling, are available from $2^1/_2$-in. to 12-in. **Smith-Scott Co., Inc., CE 6-132, 6565 Mission Blvd., Riverside, Calif.**

McCARTHY DRILLS

McCARTHY UNDERGROUND HORIZONTAL DRILL

DRILLS UNDER HIGHWAYS, RAILROADS, ETC.

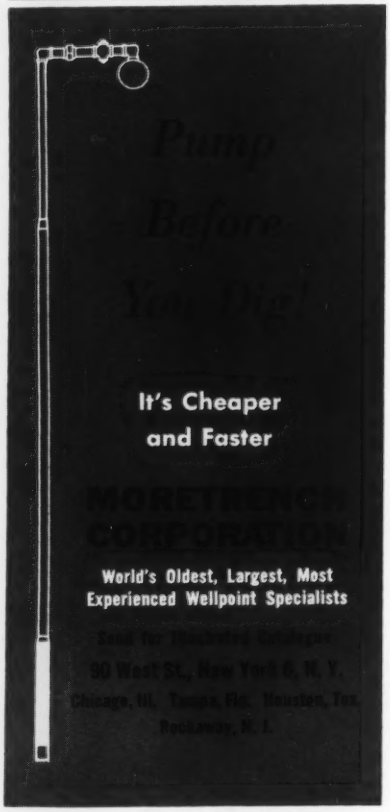
A utility money-maker! Drills through rock or earth for drainage, conduit, pipe lines, etc., without breaking the surface. Drills 4" to 24" holes up to 180 ft. long in hardpan compacted sand, gravel and shale formations.

McCARTHY VERTICAL AUGER DRILLS

BLAST HOLE DRILLING
PROSPECTING

Drills 4-6-8" diameter "dry" holes — 400 to 1,000 ft. per day. Can be mounted on truck or half-track. Hydraulically operated. Adapts to any job where ordinary rock formations need blasting.

SALEM
THE SALEM TOOL COMPANY
804 S. ELLSWORTH AVE.
SALEM, OHIO

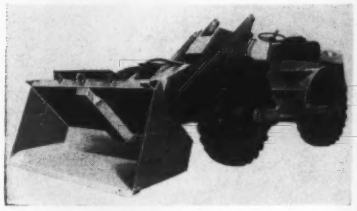


EQUIPMENT MATERIALS and METHODS

(continued)

Front End Loader

FOUR-WHEEL STEERING, two-axle oscillation and unimpaired operator visibility are exclusive features incorporated on the new model LD5T Scoopmobile. The model Scoopmobile is a 1-cu yd, 5000-lb capacity front end loader, and is unique in that it will transport a full load with the bucket raised off the ground merely enough to clear the terrain. This assures continued visibility in all phases of operation of the loader.



LD5T Scoopmobile

Four-wheel steering enables the operator to maneuver in tight spots and rough terrain, while the two-axle oscillation allows work on the roughest ground without loss of tractive power. Other standard equipment on the Scoopmobile is the torque converter, planetary drive and power steering. **Mixermobile Manufacturers, Inc., CE 6-133, 8027 Killingsworth St., Portland 20, Ore.**

Portable Mixer

A REVOLUTIONARY PORTABLE MIXER that allows builders to mix concrete, plaster and terrazo closer to their work, has been introduced. The Handy Mixer utilizes a portable electric mixing unit that is inserted into a large metal tub. The mixing unit slides into a receptacle in the tub, and the entire mixer can be assembled in 30 seconds. The tub has a capacity of five bags of pre-mixed aggregate. If more than one tub is used, several colors or types of mixes can be made on the spot by moving the mixing unit from tub to tub.

The complete unit can be easily operated and moved by one man. It is powered by a 1-hp motor and can be operated wherever there is a 115-v outlet. The Mixer eliminates the need for mortar box, screening and overnight standing of finish mix. **Master Vibrator Company, CE 6-133, 561 Stanley Ave., Dayton 1, Ohio.**

1-day seismic survey solves subsurface problem for recreation center

Plans for the 10-acre Hayden Recreation Center in Lexington, Mass., call for a playground, main building and other structures. This is a glacial till area where bedrock varies widely and boulders are common. Exploration of the site by borings alone would have been difficult, expensive and time consuming. Stone & Webster, engineers for the site exploration, called in a Gahagan Seismic Survey Crew. They started work at 9 A.M. using portable equipment, and by 4.30 that afternoon, under ideal conditions, had completed 14 profiles of bedrock elevation each 110 feet long. Final report was submitted at 2.30 the next afternoon. Later, five test borings were put down at key construction points indicated by Gahagan's findings. Correlation between borings and seismic data was good. Stone & Webster report "results of seismic survey are most satisfactory." Write for factual Bulletin No. 2 to Geophysical Survey Division, Gahagan Dredging Corp., 90 Broad St., New York 4, N. Y.

ANOTHER
GAHAGAN
CASE HISTORY

Save Draftsmen's Time

Handles anything up to 12 feet!

YOUR TYPIST CAN DO THE JOB BETTER

The Vari-Typer lettering machine is the fastest and most economical method of lettering specifications on tracings and drawings. It is four to five times faster than hand lettering and is operated by an office typist. Every letter and figure is uniformly clear and distinct. Instantly changeable type, with hundreds of different styles to choose from in sizes ranging from 6 point to 18 point. Write today for information.

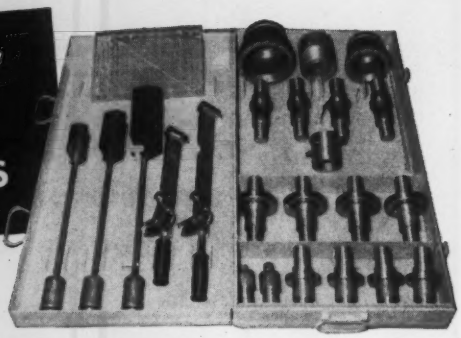
Vari-Typer

Lettering Machine

Body copy produced on DSJ Model. Headlines photo-composed on the Headliner.

RALPH C. COXHEAD CORP.
720 Frelinghuysen Ave.
Newark 12, N. J.
Please send Vari-Typer Book E-68
NAME.....
COMPANY.....
ADDRESS.....
CITY.....ZONE...STATE...

"IN-PLACE" SHEAR READINGS



FAST, ACCURATE, WITH NEW ACKER VANE TEST KIT!

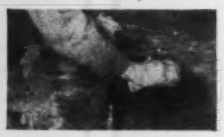
The Acker Vane Shear Test Kit has everything needed to obtain fast, accurate, "in-place" shear readings to depths of 100 feet!

It's easy to use and provides accurate soils information at low cost! For ease in carrying, the entire set of tools are packaged in a handy steel kit.

Write today for prices and free illustrated folder 700! CE

Assemble the Vane to the Rod!

Insert in Casing and Apply Pressure to the Torque Wrench!



Consult the Torque Chart for Accurate Reading!

ACKER DRILL CO., INC. 725 W. Lackawanna Avenue Scranton, Penna.

a complete line of Soil Sampling Tools, Diamond and Shot Core Drills, Drilling Accessories and Equipment

SAVE MONEY! solve Your cost problems right now with CONSTRUCTION COST CONTROL

No need to let cost problems get out of hand . . . you'll find easy solutions in this practical guide book, CONSTRUCTION COST CONTROL. Here are the answers to the complete cycle of estimating, accounting, distributing and analyzing of all operational and overhead costs. The authors are practical construction men thoroughly experienced and ready to help you with illustrations, charts, and specimen accounting forms. This 97 page book measures eight-and-a-half by eleven inches and is sturdily bound. Don't wait any longer—mail the coupon, today!

SECTIONS INCLUDE

Estimating and Preliminary Work, The Accounting System, The Classification of Construction Cost Accounts, Distribution of Costs, The Control of Costs, Financing the Contractor, Taxes and Tax Problems.

$4.00 postpaid to ASCE Members
$5.00 postpaid to non-members

Special discount on ten or more available to ASCE Student Chapters and to colleges for textbook use: $3.00 each

A must for construction men!

AMERICAN SOCIETY OF CIVIL ENGINEERS
33 West 39th St., New York 18, N. Y.

Please send.....copies of CONSTRUCTION COST CONTROL

Enclosed is check (or money order) in the amount of $.....(I am.....(I am not)..... a member of ASCE.

Name .....

Firm .....

Street .....

City .....State.....

EQUIPMENT MATERIALS and METHODS

(continued)

Clay Pipe Joints

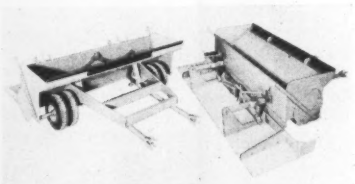
SPEED OF INSTALLATION and watertightness are the outstanding features of new clay pipe joints which can be snapped together, screwed or pressure sealed with grout. Development of Plastisol, a polyvinyl chloride plastic, is a key factor.

Plastisol rings with curved flanges are factory-bonded to the bell and around the spigot of Wedge-Lock clay pipe. The adhesive fuses the two rings into a solid mass. With Screw-Seal pipe, the spigot ends are fitted with a threaded Plastisol casting, and the pipe joined by a female-threaded phenolic collar.

For large diameter pipe an inflatable gasket has been developed which slips over the spigot and fits inside the bell. Thin grout is then pumped into the gasket through a small valve, at 50 psi. After the grout has set, a tight seal is formed. This type of joint is particularly useful in flooded trenches. **The Robinson Clay Product Co., CE 6-134, P. O. Box 1070R, Akron 9, Ohio.**

Towed Spreader

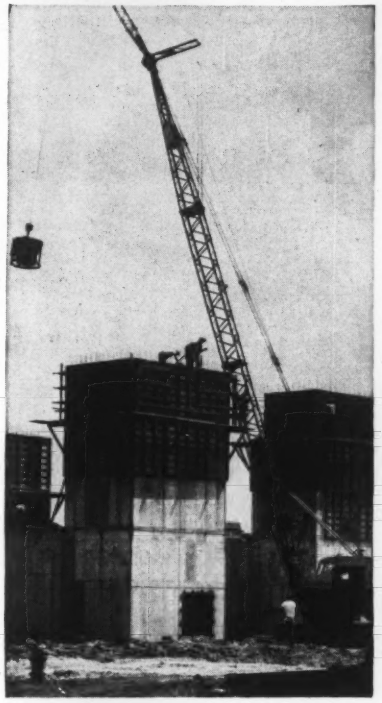
THOUGH RETAINING THE BASIC DESIGN of previous models, a new towed asphalt and aggregate spreader has been vastly improved with the inclusion of several new features. An exclusive feature on this spreader is a crown device now built into the floating screed mechanism. It permits crowns and reverse crowns up to $2^1/_2$-in. thickness. Contractors can now easily spread level, concave or convex surfaces heretofore impossible to lay with a towed spreader.



Floating Screed Mechanism

The spreader is offered in 8, 9, and 10-ft widths; screeds can be widened through the use of 12-in. extension plates. When used with open bleeder plates, these extensions smooth and level all extra material without leaving seams and ridges. The new unit will also spread limestone, slag and gravel base up to 8-in. in depth at a rate of 1 ton per minute. **Miller Spreader Corporation, CE 6-134, 4020 Simon Road, Youngstown, Ohio.**

Symons FIELD REPORT...



SYMONS FORMS USED ON TWA TEST CELLS ...

Five aircraft engine test cells, with exhaust and intake stacks 45 feet high, are being erected at Trans World Airlines' overhaul base at Mid-Continent International Airport, Kansas City, Mo.—the first cells of their kind in the United States.

These cells are on a concrete base, and 12,500 square feet of Symons Forms with Steel Cross Members were used for the 55,000 square feet of concrete forming required. Sharp Brothers Contracting Company, Kansas City was the general contractor.

TWA test cells are just one of many commercial, industrial, institutional and public works construction jobs for which Symons Forms are adaptable. Symons engineering staff gives complete service on the details of all forming jobs. Our salesmen are field-trained to give practical advice on form erection, pouring and stripping methods.

Symons Forms, Shores and Column Clamps may be rented with purchase option, all rentals to apply on purchase price. Symons Clamp & Mfg. Co., 4291 Diversey Ave., Dept. F6, Chicago 39, Ill.

In this unusual stripping procedure, panels are being removed by a worker seated in a bosun's chair suspended from a crane boom.

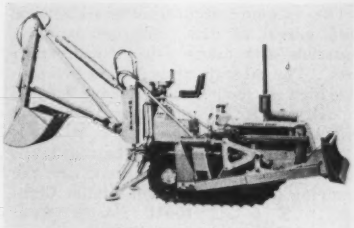
For More Information on FORMS—CLAMPS—SHORES. Write for Literature

EQUIPMENT MATERIALS and METHODS

(continued)

Hydraulic Backhoe

A MAJOR ADVANCEMENT in tractor-mounted backhoes, the hydraulic D4 backhoe of $^1/_2$-yd capacity, is designed for the Caterpillar D4 tractor. The new backhoe has full track-type tractor mobility, is capable of digging down to 13-ft and loading up to a height of 9-ft, $7^1/_2$-in. Full swing power through all of 240 degree arc is provided by rack-and-gear-type swing mechanism. This arrangement allows same amount of power to be applied at any point of swing. All moving parts operate in sealed oil bath. Hydraulic outriggers provide machine stability while digging. Each outrigger can be adjusted independently to level tractor on side slope.



Designed for Caterpillar

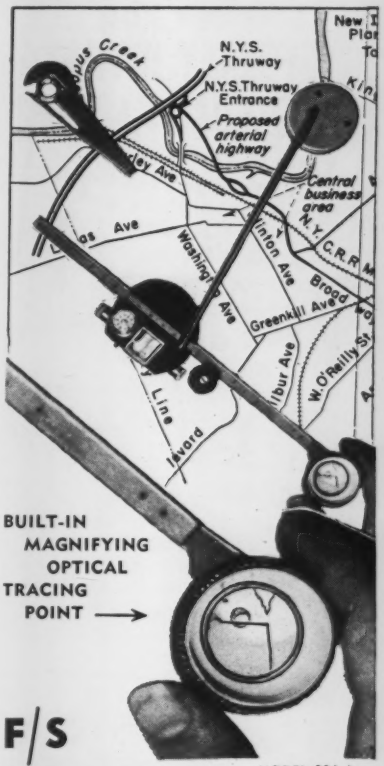
Dippers for the new D4 backhoe are available in cutting widths of 13, 21 or 29-in. They are equipped with replaceable alloy steel points crimped onto adapters from the bottom for easy replacement. **The Hyster Company, CE 6-135, 1800 North Adams St., Peoria 1, Ill.**

Wagon Drill

A COMPLETELY POWER-OPERATED WAGON DRILL has been announced to the construction and quarry industries. Called the Jr Challenger, it is a self-propelled, track-mounted drill that mounts a heavy $4^1/_2$ in. drifter, drills up to $3^1/_2$ in. diameter holes to depths of 40-ft in any formation.

All movements of feed and drill are performed hydraulically. Tramming power is provided by two air motors, which are direct-connected, thus eliminating drive chains. Each tread moves up or down independently to conform with terrain, then is locked simply by turning a valve, which provides absolute stability while drilling. The Jr Challenger drills at any angle: vertical bench holes, toe holes, horizontal holes up to $7^1/_2$ ft height, and angle holes both up and down from the horizontal. **Joy Manufacturing Company, CE 6-135, Oliver Bldg. Pittsburgh 22, Pa.**

GOODBYE EYESTRAIN!



BUILT-IN MAGNIFYING OPTICAL TRACING POINT →

MODEL 236-A

F/S OPTICAL PLANIMETER

Exclusive F/S Patent Design. Eliminates Eye-Strain, Increases Precision, Speed.

- New free-wheeling, wide-angle, magnifying lens has built-in tracing point——glides smoothly along outline, will not stick or tug—eliminates parallax.
- Finger-flick Zero Setting Control brings both wheels automatically to zero—eliminates need for initial readings and for handling measuring wheel.
- Enclosed wheel carriage keeps out dust and maintains high precision—incorporates plexiglas lens to simplify wheel readings.

Model 236A—(Illustrated) Adjustable-arm Planimeter $75.00

Model 236F—Fixed Arm 71.00

Model 237A—Universal Planimeter for both polar and linear measurements 125.00

Model 225/TER-A—Conversion Unit for conversion of polar into linear planimeter 50.00

Ask for complete literature on F/S planimeter

Serviced in U. S. A.

FILOTECNICA SALMOIRAGHI INC.

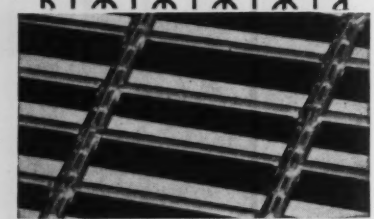
41-14 24TH STREET, LONG ISLAND CITY 1, N. Y.

You Get
MORE THAN GRATING
When You
SPECIFY IRVING

YOU GET...
Over 50 years of engineering skill and production know-how from the FOUNDERS of the open-grid flooring industry.

YOU GET...
A "fitting" grating for every purpose.

YOU GET...
Riveted, pressure-locked and welded Irving gratings in steel; and Irving aluminum gratings in riveted and pressure-locked types, designed for your industrial flooring problems.



YOU GET...
Irving engineering procedures which assure precisely fabricated panels designed from your floor plan or sketch for quick, easy installation.

YOU GET...
Prompt delivery anywhere.

IRVING SUBWAY GRATING CO., INC.
ESTABLISHED 1902

OFFICES and PLANTS at
5068 27th St., Long Island City 1, N. Y.
1808 10th St., Oakland 20, California

EQUIPMENT MATERIALS and METHODS

(continued)

Volume Dump Trailer

IN A NEW VOLUME DUMP TRAILER, by the simple device of using cable operation for actuating the dump body, the usual costly and heavy hydraulic hoist mechanisms have been eliminated. As a result the number of moving parts has been reduced to only five in number.

The volume dump trailer is ideal for sand, gravel, fill dirt, pulverized building materials and many other construction jobs. The cable dump is designed to provide high efficiency and to give top earning capacity under all conditions. Dumping with the tractor jacknifed up to 90-deg is possible, and the hanger mechanism keeps all wheels on the ground throughout the dumping period. **Fruehauf Trailer Company, CE 6-136, 10941 Harper Ave., Detroit, Mich.**

Floor Loader

A FLOOR LOADER has been developed to avoid many of the complications of putting materials and machinery on different floors while a building is being constructed. Its purpose is to put material on the floors of a building around its perimeter, nearest to the place it will be used. It will place a 5-ton maximum load 40-in. in from the edge of a building.

Material handling by elevators subjects floors to concentrated traffic converging to and from the elevator. A floor loader and crane eliminates such traffic and as each floor cures, construction can progress more rapidly. Various dimensions of loaders can be built to cover specific applications. **A. F. Kuehne, CE 6-136, 73 Warren St., Needham, Mass.**

Steel Corner Tape

FLEXIBLE, REVERSIBLE STEEL CORNER TAPE that produces a perfect corner bead on all dry-wall construction is now being marketed in a new self-dispenser box. The tape, for use on inside and outside corners, caps, and other dry-wall taping applications, is easily applied. After applying joint cement, the tape is pressed into the corner with the metal inside, and excess cement is removed with scraper or trowel.

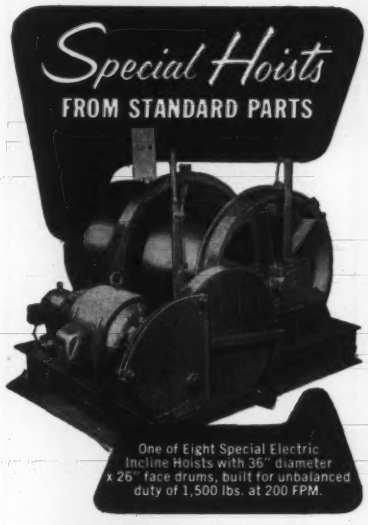
The handy dispenser package, containing a continuous 100-ft roll, permits the user to cut off the exact amount needed for the job, eliminating waste. Unused tape remains in the box, instantly ready for the next application. **Tamms Industries, Inc., CE 6-136, 221 North La Salle St., Chicago 2, Ill.**

SAVE MONEY
when pouring concrete
RENT ECONOMY STEEL FORMS

Easily and quickly assembled
Complete supervisory service
Adaptable to wide use
Save time and material
Other forms available on a purchase basis

Write for catalog to
ECONOMY FORMS CORP.
HOME OFFICE • DES MOINES, IOWA

DISTRICT SALES OFFICES: St. Louis, Mo. • Kansas City, Mo. • Lincoln, Neb. • Minneapolis, Minn. • Ft. Wayne, Ind. • Milwaukee, Wisc. • Cincinnati, Ohio • Cleveland, Ohio • Metuchen, N. J. • Rochester, N. Y. • Springfield, Mass. • Washington, D. C. • Decatur, Ga. • Dallas, Texas • Los Angeles, Calif. • Oakland, Calif. • Denver, Colo.


Special Hoists
FROM STANDARD PARTS
One of Eight Special Electric Incline Hoists with 36" diameter x 26" face drums, built for unbalanced duty of 1,500 lbs. at 200 FPM.

• By modifying and re-combining our standard parts, Superior-Lidgerwood-Mundy can engineer hoists to meet your specific requirements at the lowest possible cost.

Write for bulletins and catalogs

SUPERIOR LIDGERWOOD MUNDY CORPORATION

Main Office and Works: SUPERIOR, WISCONSIN, U. S. A.
New York Office, 7 Dey Street, New York 7, N. Y.

Bibliography on Machinery Foundations

The Engineering Societies Library announces its new Bibliography (No. 11), which provides annotated references from 1924 to 1955 on machinery foundations —design, construction, vibration elimination.

Copies available at $2 each

Eng. Soc. Library
29 West 39th Street, New York 18, N. Y.

Please send me.....copies of "The ESL Bibliography, No. 11"

Payment is enclosed herewith

Name .....

Address .....

City .....

FILMS AVAILABLE

"The Story of Emeri-Crete"—A sound and color motion picture showing the aggregate source and preparation technique for heavy-duty flooring for industrial plants is now available. This 16-mm film shows the mining of Cortland Emery, one of the world's hardest minerals, which is then processed into the aggregate for Emeri-Crete flooring. The processing is shown, including crushing, screening and packaging. The 25-min film demonstrates the preparation and application of this flooring for heavy industrial use. **Walter Maguire Co., Inc., CE 6-137, 60 E. 42 St., New York 17, N. Y.**

"Digging for Profits"—A new 21-min color and sound 16-mm motion picture has just been produced explaining the functions of the Gradall in today's construction activity and showing the machine on a wide variety of applications in all parts of the nation. The film shows the Gradall machine in operation on such jobs as digging ditches, laying pipe, hand grading, shaping finished grades, and shaping ditches which will be lined in concrete. **The Warner & Swasey Company, CE 6-137, 5700 Carnegie Ave., Cleveland, Ohio.**

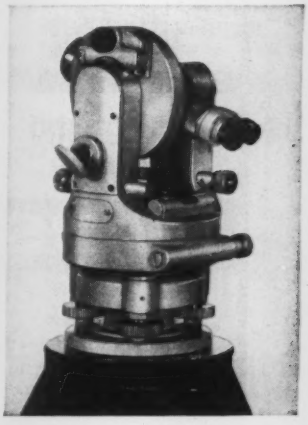
"The Man With the Trowel"—An informational colored motion picture that shows how better, uniform quality concrete is being produced through improved control of water, air and rate of hardening has been announced. The film treats with problems in meeting concrete requirements caused by variables in materials and conditions. Demonstrating the need for controlling these variables to obtain hour by hour uniformity of good concrete, it shows how Pozzolith is being employed to accomplish this result. The film tells a story of quality control that will be of interest to all who are associated in any way with concrete. **The Master Builders Co., CE 6-137, 7016 Euclid Ave., Cleveland 3, Ohio.**

"Freedom of the American Road"—Methods used by typical American communities to solve their auto safety, traffic and highway construction problems are portrayed in a new motion picture. Produced as a public service, the 27-min, 16-mm sound movie shows how individuals and groups in communities across the country have worked together to build better roads, develop traffic-control methods and promote driver and pedestrian safety. The film contains sequences on solution of traffic and safety problems in San Francisco, Boston, and Pittsburgh; on a highway improvement program in North Carolina, and on a traffic-safety campaign which won for St. Joseph, Mo., the nation's highest safety award. **Ford Motor Company, Film Library, CE 6-137, 16400 Michigan Ave., Dearborn, Mich.**

SURVEYING NEWS

NEW THEODOLITE SETS UP QUICKLY, EVEN IN THE WIND

Has this been your problem? Now—old-type mechanical plumb-bob replaced by can't-miss optical principle



- Improved Theodolite reads horizontal and vertical circles simultaneously, through same eyepiece
- Reads direct to 1 min. with no matching of lines—no parallax
- Amazingly blur-free—small, compact, moisture-proof, dust-proof.

Mail this coupon for details

FENNEL

INSTRUMENT CORP. OF AMERICA
45-22 Pearson St., Long Island City, N.Y.

Please send me Booklet D with information on Fennel . . .

☐ Double bubble ☐ Alidades
☐ Other levels ☐ Collimeters
☐ Transits ☐ Stands
☐ Combinations ☐ Tripods
☐ Theodolites ☐ Repair of present instruments, (any make)

NAME.....

ADDRESS.....

something new on

MARS

Staedtler has been coming up with something new in pencils ever since the first Staedtler pencils were made three centuries ago.

Now it's the new, sturdy, solid brass lead sharpener built into the Technico Mars-Lumograph push-button lead holder. Saves you work, time, money.

Get the imported Mars Technico lead holder and leads today—they are the best, yet cost no more.

The 1001 Mars Technico clutch mechanism holds leads securely; light in weight, perfectly balanced; $1.50 each, less in quantity.

1904 Mars-Lumograph leads are so opaque, inking-in is unnecessary; won't flake or smudge, give better reproduction. Perfectly graded in 18 degrees—EXB to 9H; $1.20 doz., less in quantity.

J.S. STAEDTLER, INC.
HACKENSACK, NEW JERSEY
at all good engineering and drawing material suppliers

From the MANUFACTURERS

SANDWICH WALL: A unique aluminum and cellular glass "Sandwich" wall, only 3½-in. thick, is being used on the new bottling plant of the Duquesne Brewing Company in Pittsburgh. The wall consists of two sheets of ribbed aluminum siding with a core of Foamglass cellular glass insulation. . .**$200,000 ORDER:** Convair has ordered more than $200,000 worth of Standard Pressed Steel Company's new Hi-Psi bolts for critical wing-to-fuselage connections on the new F-102A supersonic jet interceptor. . .**SNO-TRAIN:** R. G. LeTourneau, Inc., has just delivered its new cross-country freight train to the Army for use in the Arctic. The block-long carrier travels on 16 tires, each 4-ft wide and 10-ft high. . . **10TH ANNIVERSARY:** The Ramset Fastening System has produced 30,000 of their power-actuated fastening tools during its 10-yr history. . .**HURRICANE CHAMBER:** A new test chamber for creating the static equivalent of a 150-mph hurricane has been completed by the Trucson Steel Division. It will be used to test new designs of steel-framed windows for large buildings. . .**PLASTIC FILM:** Olin Mathieson Chemical Corporation is offering polyethylene film for the first time to the construction industry for use as a moisture and vapor barrier in buildings. . .**NAME CHANGE:** The Industrial Power Division of International Harvester Company is now known as the Construction Equipment Division. The change applies to name only and does not affect personnel or line of equipment. . . **PLANT SITE:** Aurora, Ill., has been chosen as the site for a new plant of Caterpillar Tractor Co. Construction starts this month; upon completion D2 and D4 crawler tractors will be built there. . .**OVERSEAS EXPANSION:** Koppers Company, Inc., has formed a new international company to handle overseas activities. World Wide Surveys Pty., Ltd. is the name of the new Australian subsidiary formed by Fairchild Aerial Surveys, Inc. . .**OPERATION HELICOPTER:** A 1,500-ft canyon wall in Utah posed a problem for the Atlas Corporation when it decided to drill uranium testings at its top. The problem was overcome by using a helicopter to fly a Le Roi 105-cfm portable air compressor, piece by piece, to the top. The then reassembled compressor worked efficiently despite an altitude of 7000-ft and a temperature of 20-deg below zero. . . **APPOINTMENTS:** Myron W. Rhoten has been named Managing Director of Allis-Chalmers Great Britain, Ltd., with headquarters in Essedine, England. . .R. L. Rhodes succeeds J. E. Sweitzer, who recently retired after 42-yr of service, as General Sales Manager of the Alpha Portland Cement Company. . .W. A. Brobston has been appointed as Eastern Sales Manager of the Lehigh Portland Cement Company.

TIDE GATES

Fig. B-68, Type M
(CIRCULAR)

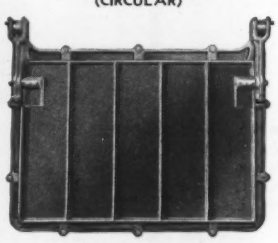
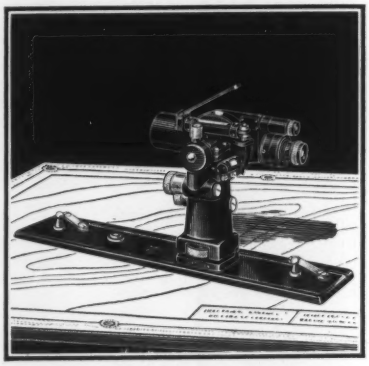


Fig. B-61, Type MM
(RECTANGULAR)

BROWN & BROWN, INC.
LIMA, OHIO, U. S. A.



WATTS MICROPTIC ALIDADES
FINEST IN THE FIELD

For swift accurate field mapping and surveying, leading surveyors rely on the Watts Microptic Alidade. The Watts Alidade is highly accurate, compact, light weight, versatile and dependable. See the advanced-design Watts Microptic Alidade with exclusive pillar levelling at your nearby Dietzgen Dealer. Made by Hilger & Watts, Ltd., London; sold and serviced in the United States by the Eugene Dietzgen Co.

EUGENE DIETZGEN CO.

Chicago • New York • San Francisco • New Orleans • Los Angeles • Pittsburgh • Washington Philadelphia • Milwaukee • Seattle • Denver Kansas City • *Dealers in All Principal Cities*

DIETZGEN

PROCEEDINGS AVAILABLE

For Instructions and Key to Abbreviations, see next page. Each member is entitled to 100 free "Proceedings Papers" yearly, ordered from these pages, plus all papers of the Technical Divisions in which he registers. The latter papers will be mailed automatically. To register, mail the enrollment form on page 141 to Society Headquarters. Discussion of a paper will be received during the four full months following the month of issue.

---

961. **Cost Allocation for Multi-Purpose Water Projects, by N. B. Bennett, Jr.** (IR) The Separable Cost-Remaining Benefits method of cost allocation, its dependence on benefits and alternate costs, and the meanings attached to single-purpose alternate costs, specific and separable costs, joint costs, and remaining project costs are discussed.

962. **Design of Major Drainage Canals, by E. W. Eden, Jr.** (IR) This paper is chiefly concerned with areas in which the only practical measure for the control of floods is the improvement and enlargement of existing outlets or by the diversion of excess water to some alternative, more economical, outlet.

963. **Design of the Modern Industrial Plant, by E. X. Tuttle.** (CP) Dominating the trends in industrial plant design are the conditions and extent of human toil and flexibility. Planners and architects must assure reduction in work load and flexibility of industrial facilities while protecting the investments of individuals, industries, and the community.

964. **Urban Redevelopment Can Implement Mass Transit, by W. H. Claire.** (CP) Sharing the high first cost of installation of modern profitable rapid mass transit facilities is feasible through the redevelopment of areas in the vicinity of the transit facility. Part of the tax revenue increase from these areas is used to encourage the development of the transit facility.

965. **Developing Port Facilities on Houston's Ship Channel, by F. H. Newnam, Jr.** (WW) Studies were made to determine the best layout for development of wharves on a new tract on the Houston Ship Channel. Particular attention was given to the comparative advantages of marginal type wharves or finger piers.

966. **Flood Protection at Wichita and Valley Center, Kan., by M. W. De Geer.** (WW) The flood problem at Wichita, Kan., is discussed, as well as the design of a system of floodways and levees for the protection of the city and its environs. The project structures and the status of construction scheduled for completion in 1958 are also described.

967. **Improving the Gulf Intracoastal Canal in Texas, by W. P. McCrone.** (WW) Because of increased traffic, the users of the Gulf Intracoastal Canal requested that its size be increased from New Orleans, La., to Brownsville, Tex. The studies and analyses made to determine the extent of the justified enlargement are discussed.

968. **Design Problems Involved in Protection from Tsunamis, by K. Kaplan.** (WW) Laboratory studies of Tsunami (earthquake-generated) type water waves were made to assess the importance of various wave parameters in the design of protective structures along shorelines. Relationships between the dimensionless parameter wave height, wave length, and wave run-up on both beach slopes and seawall faces were developed.

969. **New Locks on Lower Mississippi and Gulf Coast, by N. R. Moore.** (WW) This paper concerns the principal navigation locks constructed since World War II and those scheduled for construction in the near future. The diverse requirements governing the design and some unusual construction problems are described.

970. **Specifications for Structures of Aluminum Alloy 6061-T6: Second Progress Report of the Committee of the Structural Division on Design in Lightweight Structural Alloys.** (ST) These specifications cover allowable stresses, design rules, and fabrication procedures for structures built of the aluminum alloy known commercially as 6061-T6 (formerly 61S-T6).

971. **Specifications for Structures of Aluminum Alloy 2014-T6: Third Progress Report of the Committee of the Structural Division on Design in Lightweight Structural Alloys.** (ST) These specifications cover allowable stresses, design rules, and fabrication procedures for riveted heavy-duty structures built of the high-strength aluminum alloy known commercially as 2014-T6 (formerly 145-T6).

972. **Discussion of Proceedings Papers 561, 586, 652, 734, 763, 809, 825, 828, 829, 830, 851.** (ST) K. V. Taylor closure to 561. J. D. Griffiths closure to 586. H. A. Miklofsky closure to 652. Corrections to B. C. F. Wei in 879 on 734. E. Giangreco on 763. P. W. Abeles, and L. W. Mensch on 809. A. W. Hainlin, and T. C. Rathbone on 825. E. N. W. Lane, and A. C. Scordelis on 828. C. L. Chang, and H. A. Sawyer on 829. E. G. Stern, and N. B. Jones on 830. B. G. Johnston on 851.

973. **Dynamic Stresses in Continuous Plate Girder Bridges, by R. C. Edgerton and G. W. Beecroft.** (ST) Results are presented of tests conducted by the Bureau of Public Roads and the Oregon State Highway Department on two three-span continuous

ORDER FORM FOR PROCEEDINGS PAPERS

(For ASCE Member use only)

American Society of Civil Engineers
33 W. 39th St., New York 18, N. Y.

Please send me the PROCEEDINGS PAPERS which I have circled below.

961 962 963 964 965 966 967 968 969 970 971 972 973 974 975 976
977 978 979 980 981 982 983 984 985 986 987 988 989

If more than one copy of a paper is desired (*for which a charge of 25¢ per copy will be levied*) indicate here:

_____

_____

Name (*please print*) Membership Grade

Address

_____

_____

Signature Date

plate girder bridges in Oregon. The test records provide values of frequency of vibration, amplitude of vibration, and amplitude of strain oscillation.

974. Earthquake Stresses in Spherical Domes and in Cones, by E. P. Popov. (ST) Formulas for the primary or membrane stresses in spherical domes and cones due to earthquake loading are given. It is shown how the ordinary flexure formula may be used directly in determining the meridianal membrane stresses.

975. Control of Rio Grande by United States and Mexico, by J. C. Bustamante and J. F. Friedkin. (WW) Since the Rio Grande was established as a boundary between the United States and Mexico, the problems of channel realinement, flood control, irrigation, and power development have been dealt with successfully by a joint commission.

976. Sand By-Passing at a Virginia Tidal Inlet, by T. J. McDonald and M. A. Sturgeon. (WW) The paper describes the sand barrier effect of a nearby tidal inlet on the beach erosion problem at Virginia Beach, Va., and sets forth criteria for the design of a sand by-passing system to compensate for this effect.

977. Economic Criteria for Water Development Projects, by J. J. Rasmussen. (IR) Water development projects must be planned and their feasibility evaluated in terms of national objectives with due consideration given to all the various facets of a project. Certain specific economic criteria must be considered.

978. The Effect of Airport Distance on Traffic Generation, by J. C. Buckley. (AT) Before a choice is made between a distant and a close-in location for a municipal airline airport, the effect of airport distance on air traffic generation and the resultant financial effects should be evaluated.

979. The Design of Non-Rigid Overlays for Concrete Airfield Pavements, by F. M. Mellinger and J. P. Sale. (AT) The part played by the Corps of Engineers' (United States Department of the Army) Pavement Investigational Program pertaining to the development of design criteria for non-rigid overlays of concrete airfield pavements is summarized.

980. What is the Story of Aviation Today? by J. D. Blatt. (AT) From historical data, trends in the design of air transportation facilities are established and air transportation forecasts are made. 1960 and 1965 forecasts of airline passengers, air cargo, general aviation, low visibility operation, and international and overseas air commerce are discussed.

981. Benefits of Water Development Projects, by E. R. Fogarty. (IR) The extent to which uniform procedures for analyses of benefits and costs by water development agencies can be meaningful is limited by different legislative requirements, project purposes, and types of projects.

982. Discussion of Proceedings Paper 788. (IR) M. L. Albertson and H. K. Liu on 788.

983. Highway Engineering Manpower—Recruiting and Training of Graduates, by R. Winfrey. (HW) There are two sources of recruitment for filling the need for highway engineers—high school graduates and college civil engineering graduates. Highway departments should give more attention to the selection and training of employees than to equipment and materials.

984. Highway Engineering Manpower: Engineering Education Aspects, by H. E. Davis. (HW) Those factors which relate to education and training and which have a bearing on the highway manpower problem are summarized. Improved procedures and the increased use of engineering technicians can avoid a crisis caused by the increased output from highway agencies.

985. Discussion of Proceedings Papers 703, 783, 824, 868. (HW) C. C. Wiley, and A. H. Brownfield on, and P. Hartman closure to, 703. C. E. Kindsvater, and P. R. Neeley on 783. P. H. Calahan, F. W. Holden, and R. H. Griffiths on 824. Corrections to 868.

986. Limit Design for Buildings, by B. C. Ringo. (ST) A comparison is drawn of limit design to elastic design methods as used with structural steel. Some of the advantages and inherent characteristics of a simplified application of the method of limit design are presented, as they apply to typical structural steel framing for multi-story buildings.

987. A Pattern of Interstation Airline Travel, by D. M. Belmont. (AT) An analysis is made of airline travel between large and medium hubs. It is suggested that, for stations more than 800 miles apart, the number of trips between any two stations depends primarily on the total traffic at each of them and the quality of service.

988. Transportation Planning: Prospects for Coordination, by B. W. Marsh. (CP) Coordination in transportation planning has been almost completely lacking. Solutions to the problems of transportation conditions in the metropolitan areas can only be arrived at by cooperation among municipal agencies and civic and planning groups.

989. The New Federal-Aid Airport Program, by H. H. Howell. (AT) The author presents a review of the development of the air transport industry, its growth, its sociological implications, and the problems anticipated with the advent of jet transport aircraft. The development of federal assistance for airports is traced and the Programming Standards and Planning Standards of the Federal Airport Act of 1955 are given.

INSTRUCTIONS

1. Every ASCE member can be registered in two of the Technical Divisions and receive automatically all papers sponsored by those Divisions. **Such registration will be effective 30 days after the receipt of the registration form.**

2. In addition to those papers sponsored by the Divisions in which he is registered, a member is entitled to 100 different papers during a fiscal year beginning October 1.

3. Members' accounts will be charged 25¢ each for additional duplicate copies of a paper and for papers in excess of his free allotment.

4. Papers should be ordered by serial number. The member should keep a record of Papers ordered to avoid unwanted duplication.

5. Non-members of the Society may order copies of Proceedings papers by letter with remittance of 50¢ per copy; members of Student Chapters, 25¢ per copy.

Standing orders for all Papers in any calendar year may be entered at the following annual rates: Members of ASCE, $12.00; members of Student Chapters, $12.00; non-members, $20.00, plus foreign postage charge of $0.75, libraries, $10.00.

TRANSACTIONS. Specially selected PROCEEDINGS papers with discussions will be included in TRANSACTIONS. Annual volumes of TRANSACTIONS will continue to be available at the current established annual subscription rates.

	To Members	To Non-Members
Morocco-grained binding	$4.00	$18.00
Cloth binding	3.00	17.00
Paper binding	2.00	16.00

KEY TO TECHNICAL DIVISION SPONSORSHIP

(AT) Air Transport
(CP) City Planning
(CO) Construction
(EM) Engineering Mechanics
(HW) Highway
(HY) Hydraulics
(IR) Irrigation and Drainage
(PO) Power
(SA) Sanitary Engineering
(SM) Soil Mechanics and Foundations
(ST) Structural
(SU) Surveying and Mapping
(WW) Waterways and Harbors

Professional Services

Listed alphabetically by states

EWIN ENGINEERING CORPORATION
Consulting Engineers
Investigations, Reports, Appraisals, Estimates and Management Surveys, Port Facilities, Foundations, Industrial Plants, Bridges and Structures
General Offices **Mobile, Ala.**

PALMER & BAKER, INC.
Consulting Engineers and Architects
Tunnels — Bridges — Highways — Airports — Industrial Buildings — Harbor Structures — Soils, Materials & Chemical Laboratories
Mobile, Ala. **New Orleans, La.**
Harvey, La.

JOHN S. COTTON
Consulting Engineer
Hydroelectric, irrigation, water supply, and multiple purpose projects, flood and erosion control, river basin development planning, dams and their foundations, tunnels, marine structures, valuations, rates.
24 Evergreen Drive, Kentfield, Calif.

DAMES & MOORE
Soil Mechanics Engineering
Los Angeles • San Francisco • Portland
Seattle • Salt Lake City • Chicago
New York • Atlanta • London
General Offices, 816 West Fifth Street
Los Angeles 17, Calif.

FAIRCHILD AERIAL SURVEYS INC.
Aerial Photography • Contour Maps
Airborne Geophysical Surveys
Highway Maps • City Maps
224 E. 11th St., Los Angeles 15
New York • Chicago • Atlanta • Boston

INTERNATIONAL ENGINEERING COMPANY INC.
Engineers
Investigations—Reports—Design
Procurement—Field Engineering
Domestic and Foreign
74 New Montgomery St.
San Francisco 5, California

KAISER ENGINEERS
Division of Henry J. Kaiser Company
ENGINEER - CONTRACTOR
Investigations - Reports - Valuations
Design - Construction
Twinoaks 3-4600
1924 Broadway **Oakland, Calif.**

MAURSETH & HOWE
Foundation Engineers
Soil Investigations—Laboratory Testing
Consultants—Engineering Geology
Construction Supervision
Offices and Laboratories:
2601 South Hill St.
Los Angeles 7, Calif.
Eastern Associate:
George R. Halton
Newark, N. J.

HAROLD HOSKINS & ASSOCIATES
(Successors to Scott & Scott, Inc.)
Consulting Engineers
Sewers and Sewage Treatment
Paving — Water Supply — Drainage
Bridges — Airports — Reports
Power Plants — Surveys
1630 Que St., Lincoln 8, Nebr.
725-9th St., Greeley, Colorado

DUVAL ENGINEERING & CONTRACTING CO.
General Contractors
FOUNDATION BORINGS
For Engineers and Architects
Jacksonville **Florida**

RADER ENGINEERING CO.
Water Works, Sewers, Refuse Disposal, Ports, Harbors, Flood Control, Bridges, Tunnels, Highways, Airports, Traffic, Foundations, Buildings, Reports, Investigations, Consultations
111 N.E. 2nd Avenue Miami, Florida

ALVORD BURDICK & HOWSON
Consulting Engineers
Water Works, Sewerage, Water Purification, Sewage Treatment, Flood Relief, Power Generation, Drainage, Appraisals.
20 North Wacker Drive, Chicago 6, Ill.

CONSOER, TOWNSEND & ASSOCIATES
Water Supply, Sewerage, Flood Control & Drainage, Bridges, Express Highways, Paving, Power Plants, Appraisals, Reports, Traffic Studies, Airports, Gas and Electric Transmission Lines
351 East Ohio Street, Chicago 11, Ill.
9½ Indiana St., Greencastle, Ind.

DeLEUW, CATHER & COMPANY
Consulting Engineers
Transportation, Public Transit and Traffic Problems
Industrial Plants, Grade Separations, Railroads, Subways, Power Plants, Expressways, Tunnels, Municipal Works
150 N. Wacker Drive, 79 McAlister St.
Chicago 6, Ill. **San Francisco 2**

GREELEY AND HANSEN
Samuel A. Greeley, Paul E. Langdon, Thomas M. Niles, Kenneth V. Hill, Samuel M. Clarke, Richard H. Gould
Water Supply, Water Purification, Sewerage, Sewage Treatment, Refuse Disposal, Industrial Wastes
220 S. State Street, Chicago 4, Ill.

HARZA ENGINEERING COMPANY
Consulting Engineers
Calvin V. Davis **E. Montford Fucik**
Richard D. Harza
Hydroelectric Plants and Dams
Transmission Lines
Flood Control, Irrigation
River Basin Development
400 West Madison Street **Chicago 6**

HAZELET & ERDAL
Consulting Engineers
Bridges—Foundations
Expressways—Dams—Reports
Monadnock Block, Chicago
405 Commerce Bldg., Louisville
Dixie Terminal Bldg., Cincinnati

JENKINS, MERCHANT & NANKIVIL
Consulting Engineers
Municipal Improvements — Sewerage
Power Development — Water Systems
Traffic Surveys — Industrial Plants
Flood Control — Recreational Facilities
Airports — Investigations and Reports
805 East Miller Street
Springfield, Illinois

C. MARTIN RIEDEL
Consulting Engineer
Chemical Soil Solidification Engineering for Tunnels, Shafts, Mines, Foundations, Underground Structures
7650 S. Laflin St. **Chicago 20, Ill.**
Tel: Vincennes 6-6022, -23

SOIL TESTING SERVICES, INC.
Consulting Engineers
Carl A. Metz
John P. Gnaedinger
Soil Investigations
Foundation Recommendations and Design
Laboratory Testing
3521 N. Cicero Ave., Chicago 41, Ill.
621 Lake View Ave., Milwaukee, Wis.
1105 E. James St., Portland, Michigan

NED L. ASHTON
Consulting Engineer
Bridges, Swimming Pools, Welded Structures & Foundations, Design & Strengthening
820 Park Road **Iowa City, Iowa**

STANLEY ENGINEERING COMPANY
Consulting Engineers
208 S. LaSalle Street **Hershey Building**
Chicago 4, Illinois **Muscatine, Iowa**

EUSTIS ENGINEERING COMPANY
FOUNDATION AND SOIL MECHANICS INVESTIGATIONS
Soil Borings *Laboratory Tests*
Foundation Analyses *Reports*
3635 Airline Highway
New Orleans 20, La.

FROMHERZ ENGINEERS
Structural—Civil—Sanitary
Four Generations Since 1867
Water Supply, Sewerage, Structures, Drainage, Foundations, Industrial Waste Disposal
Investigations, Reports, Plans and Specifications, Supervision
816 Howard Avenue
New Orleans

MADDOX AND HOPKINS
Engineers & Surveyors
Plane and Geodetic Surveys
Topographic Maps—Photogrammetry
Highways, Utilities, Structures
8506 Dixon Ave. **Silver Spring, Md.**

WHITMAN, REQUARDT AND ASSOCIATES
Engineers
Sewerage and Water Systems, Highways, Airports, Industrial and Power Plants and Other Structures
Reports — Designs — Specifications — Supervision
1304 St. Paul Street **Baltimore 2, Md.**

TECHNICAL DIVISION

ENROLLMENT FORM

American Society of Civil Engineers
33 West 39th Street
New York 18, New York

☐ I am already enrolled
or
☐ I wish to be enrolled
in the.....
Division and receive automatically the Journal of that Division.

In addition, I wish to be enrolled in the
.....
Division and receive automatically the Journal of that Division.

(Enrollment becomes effective 30 days after receipt of this form)

(Signature)

(Please print name) (Membership grade)

PLEASE PRINT MAILING ADDRESS ONLY

(Number and Street)

(City) (State)

Professional Services

Listed alphabetically by states

CLARKESON ENGINEERING COMPANY, INC.

Highways, Bridges, Structures, Airports, Dams, Traffic Surveys, Reports, Waterfront Facilities

285 Columbus Avenue
Boston 16, Massachusetts

CRANDALL DRY DOCK ENGINEERS, INC.

Railway Dry Docks, Floating Dry Docks, Basin Dry Docks, Shipyards, Port Facilities
Investigation, Reports, Design

238 Main St. **Cambridge 42, Mass.**

DUFFILL ASSOCIATES, INC.

Consulting Engineers

80 Boylston St. **Boston 16, Mass.**

FAY, SPOFFORD & THORNDIKE, INC.

Engineers

Airports, Bridges, Turnpikes
Water Supply, Sewerage and Drainage
Port and Terminal Works, Industrial Bldgs.

Boston, Massachusetts

JACKSON & MORELAND, INC.

Engineers and Consultants

Design and Supervision of Construction
Reports—Examinations—Appraisals
Machine Design—Technical Publications

Boston **New York**

METCALF & EDDY

Engineers

Investigations Reports Design
Supervision of Construction and Operation
Management Valuation Laboratory

Statler Building
Boston 16

BENJAMIN S. SHIENWALD

Architectural Consultants
on
Engineering Projects
Design—Supervision—Reports

85 South Street, Boston 11, Mass.

The Thompson & Lichtner Co., Inc.

Civil and Industrial Engineers

Design, Supervision, Testing, Engineering and Production Studies. Special Structures, Tunnels, Airports, Highways, Foundations.

Office and Laboratory—Brookline, Mass.

BLACK & VEATCH

Consulting Engineers

Water—Sewage—Electricity—Industry, Reports, Design Supervision of Construction Investigations, Valuation and Rates.

4706 Broadway **Kansas City 2, Mo.**

BURNS & McDONNELL

Engineers-Architects-Consultants

Kansas City, Missouri **Phone**

P. O. Box 7088 **DElmar 3-4375**

GUNITE CONCRETE & CONSTRUCTION COMPANY

Engineers—Cement Gun Specialists—Contractors

Linings, Encasing, Insulating, Repairing, Fireproofing, New Construction

1301 Woodsweather Rd., Kansas City 5
2016 West Walnut, Chicago 12, Illinois
3206 Houston, Houston 9, Texas
4261 Olive Street, St. Louis 8, Mo.
Milwaukee and Twin Cities—Denver—New Orleans

SVERDRUP & PARCEL, INC.

Engineers — Architects

Bridges, Structures and Reports
Industrial and Power Plant Engineering

915 Olive Street **St. Louis 1, Mo.**
417 Montgomery St., San Francisco 4, Cal.

A. L. ALIN

Consulting Engineer

5927 N. 24 St.
Omaha, Nebraska

Dams, Hydroelectric Power
Flood Control

BERGER ASSOCIATES

Consulting Engineers

Studies Design Supervision
Expressways Airfields
Structures Foundations

177 Oakwood Ave., Orange, N. J.
227 Pine Street **Harrisburg, Penna.**
Baltimore, Md.

GREER ENGINEERING Associates

Foundation Designs and Analyses
Airphoto Soils and Geological Mapping
Undisturbed Sample Borings
Field and Laboratory Soil Tests
Geological Studies for Engineering Projects
Earth Dam Design and Control

98 Greenwood Ave., Montclair, N. J.

EDWARDS, KELCEY AND BECK

Consulting Engineers

Reports, Design, Supervision, Subways, Expressways, Traffic, Parking, Harbor Works, Bridges, Tunnels, Housing and Industrial Developments

Newark, N. J.
New York **Philadelphia** **Boston**

PORTER, URQUHART, McCREARY & O'BRIEN
O. J. Porter & Co.

Consulting Engineers

Airports—Highways—Dams—Structures
Foundations—Stabilization—Pavements

415 Frelinghuysen Ave., Newark 5, N. J.
625 Eighth Ave., New York 18, N. Y.
3568 West Third St., Los Angeles 5, Calif.
516 Ninth St. **Sacramento 14, Calif.**
503 Market St., San Francisco 5, Calif.

AMMANN & WHITNEY

Consulting Engineers

Design and Construction Supervision of Bridges, Highways, Expressways, Buildings, Special Structures, Airport Facilities

111 Eighth Avenue, New York 11, N. Y.
724 E. Mason St., Milwaukee 2, Wisc.

BOGERT AND CHILDS

Consulting Engineers

Clinton L. Bogert Fred S. Childs
Ivan L. Bogert Donald M. Ditmars
Robert A. Lincoln Charles A. Manganaro
William Martin

Water and Sewage Works • Refuse Disposal • Drainage • Flood Control • Highways & Bridges • Airfields

145 East 32nd St., New York 16, N. Y.

BOWE, ALBERTSON & ASSOCIATE

Engineers

Sewage and Water Works—Industrial Wastes — Refuse Disposal — Municipal Projects — Industrial Buildings — Reports Plans — Specifications — Supervision of Construction and Operation—Valuation Laboratory Service

75 West Street **New York 6, N. Y.**

FRANK L. EHASZ

Consulting Engineers

Highways, Expressways, Bridges, Buildings, Port Development, Airports, Dams, Flood Control, Tunnels, Sewerage, Water Supply

40-29 27th Street
Long Island City 1, N. Y.

THE FOUNDATION COMPANY

Engineered Construction

Power Plants — Drydocks — Bridges
Deep Caissons — Shipways
Heavy Foundations

THE FOUNDATION COMPANY
57 William Street, New York 5, N. Y.
BO 9-8111

HARDESTY & HANOVER

Consulting Engineers

Long Span and Movable Bridges, Hanover Skew Bascule, Grade Eliminations, Foundations, Expressways and Thruways, Other Structures, Supervision, Appraisals and Reports.

101 Park Avenue, New York 17, N. Y.

FREDERIC R. HARRIS, INC.

Consulting Engineers

Harbors, Piers & Bulkheads, Drydocks, Foundations, Soil Mechanics, Industrial Plants, Water Supply, Flood Control, Airports, Highways, Bridges, Power, Sanitary & Industrial Waste Disposal

27 William Street **New York 5, N. Y.**
Fidelity Phila. Trust Bldg., Philadelphia

HAZEN & SAWYER

Engineers

Richard Hazen **Alfred W. Sawye**

Water Supply and Sewage Works
Drainage and Flood Control
Reports, Design, Supervision of Construction and Operation
Appraisals and Rates

122 East 42nd St., New York 17, N. Y.

B. K. HOUGH

Consulting Engineer

Soil & Foundation Engineering

Site Investigation, Soil Testing, Design Analysis for Earthworks, Foundations and Pavements, Field Inspection, Engineering Reports, Consultation

121 E. Seneca St. **Ithaca, New York**

HOWARD, NEEDLES, TAMMEN & BERGENDOFF

Consulting Engineers

Bridges, Structures, Foundations
Express Highways
Administrative Services

1805 Grand Avenue **55 Liberty Street**
Kansas City 6, Mo. **New York 5, N. Y.**

KING & GAVARIS

Consulting Engineers

Bridges Highways Toll Roads —Arterials—Foundations— Reports Investigations Surveys Supervision of Construction

425 Lexington Ave. **New York**

LEGGETTE, BRASHEARS & GRAHAM

Consulting Ground Water Geologists

Water Supply, Salt Water Problems, Dewatering, Recharging, Investigations, Reports.

551 Fifth Avenue, New York 17, N. Y.

LOCKWOOD, KESSLER & BARTLETT, INC.

Engineers *Surveyors*

Civil Engineering Investigations, Reports, and Designs, Supervision of Construction, Cadastral, Geodetic, Topographic & Engineering Surveys, Photogrammetric Engineering and Mapping

375 Great Neck Rd., Great Neck, N. Y.

MORAN, PROCTOR, MUESER & RUTLEDGE

Consulting Engineers

Foundations for Buildings, Bridges and Dams, Tunnels, Bulkheads, Marine Structures, Soil Studies and Tests, Reports, Design and Supervision.

420 Lexington Ave., New York 17, N. Y.

PARSONS, BRINCKERHOFF HALL & MACDONALD

Engineers

Bridges, Highways, Tunnels, Airports, Subways, Harbor Works, Dams, Canals, Traffic, Parking and Transportation Reports, Power, Industrial Buildings, Housing, Sewerage and Water Supply.

51 Broadway **New York 6, N. Y.**

E. LIONEL PAVLO

Consulting Engineer

Design, Supervision, Reports
Bridges, Highways, Expressways
Marine Structures, Industrial Construction, Public Works, Airports

7 E. 47th St. **New York 17, N. Y.**

MALCOLM PIRNIE ENGINEERS

Civil & Sanitary Engineers

Malcolm Pirnie **Ernest W. Whitlock**
Robert D. Mitchell **Carl A. Arenander**
Malcolm Pirnie, Jr.

Investigations, Reports, Plans
Supervision of Construction and Operations
Appraisals and Rates

25 W. 43rd Street, New York 36, N. Y.

THE PITOMETER ASSOCIATES, INC.

Engineers

Water Waste Surveys
Trunk Main Surveys
Water Distribution Studies
Water Measurement and Special Hydraulic Investigations

New York, 50 Church St.

ALEXANDER POTTER ASSOCIATES

Consulting Engineers

Water Works Sewerage, Drainage, Refuse Incinerators, Industrial Wastes, City Planning

50 Church Street, New York 7, N. Y.

Professional Services

Listed alphabetically by states

PRAEGER-KAVANAGH
Engineers
126 East 38th St., New York 16, N. Y.

SEELYE STEVENSON VALUE & KNECHT
CONSULTING ENGINEERS
Richard E. Dougherty, Consultant
Manufacturing Plants
Heavy Engineering
Structural Mechanical Electrical
101 Park Ave. New York 17, N. Y.

SEVERUD-ELSTAD-KRUEGER
Consulting Engineers
Structural Design—Supervision—Reports
Buildings—Airports—Special Structures
415 Lexington Ave., New York 17, N.Y.

SINGSTAD & BAILLIE
Consulting Engineers
Ole Singstad David G. Baillie, Jr.
Tunnels, Subways, Highways, Foundations, Parking Garages
Investigations, Reports, Design, Specifications, Supervision
24 State St. New York 4, N. Y.

FREDERICK SNARE CORPORATION
Engineers-Contractors
Harbor Works, Bridges, Power Plants
Dams, Docks and Foundations
233 Broadway, New York 7, N. Y.
Santiago, Chile San Juan, P. R.
Havana, Cuba Lima, Peru
Bogota, Colombia Caracas, Venezuela

D. B. STEINMAN
Consulting Engineer
BRIDGES
Design, Construction, Investigation, Reports, Strengthening, Advisory Service
117 Liberty Street, New York 6, N. Y.

TIPPETTS-ABBETT-McCARTHY-STRATTON
Engineers
Ports, Harbors, Flood Control Irrigation
Power, Dams, Bridges, Tunnels
Highways—Railroads
Subways, Airports, Traffic, Foundations
Water Supply, Sewerage, Reports
Design, Supervision, Consultation
62 West 47th Street, New York City

THE J. G. WHITE ENGINEERING CORPORATION
Engineers & Constructors
80 Broad St., New York 4, N. Y.

THE AUSTIN COMPANY
Design — Construction — Reports
Plant Location Surveys — Domestic & Foreign Work
16112 Euclid Avenue, Cleveland, Ohio
New York Detroit Oakland
Chicago Houston Seattle
Los Angeles

HAVENS AND EMERSON
W. L. Havens A. A. Burger
J. W. Avery H. H. Moseley
F. S. Palocsay E. S. Ordway
Frank C. Tolles, Consultant
Consulting Engineers
Water, Sewerage, Garbage, Industrial Wastes, Valuations—Laboratories
Leader Bldg. Woolworth Bldg.
Cleveland 14, O. New York 7, N. Y.

THE OSBORN ENGINEERING COMPANY
Designing—Consulting
Industrial Plants Office Buildings
Stadiums Grand Stands Field Houses
Bridges Garages Laboratories
7016 Euclid Ave. Cleveland 3, Ohio

ALBRIGHT & FRIEL INC. CONSULTING ENGINEERS
Water, Sewage, Industrial Wastes and Incineration Problems, City Planning, Highways, Bridges and Airports, Dams, Flood Control, Industrial Buildings, Investigations, Reports, Appraisals and Rates Laboratory For Chemical & Bacteriological Analyses Complete Service on Design and Supervision of Construction.
THREE PENN CENTER PLAZA
PHILADELPHIA 2, PA.

MICHAEL BAKER, JR., INC.
The Baker Engineers
Civil Engineers, Planners, and Surveyors
Airports—Highways—Sewage Disposal Systems—Water Works Design and Operation—City Planning—Municipal Engineering—All Types of Surveys
Home Office: Rochester, Pa.
Branch Office:
Jackson, Miss. Harrisburg, Pa.

CAPITOL ENGINEERING CORPORATION
Engineers-Constructors-Management
DESIGN AND SURVEYS
ROADS AND STREETS
SEWER SYSTEMS WATER WORKS
PLANNING AIRPORTS
BRIDGES TURNPIKES DAMS
Executive Offices
Dillsburg, Pennsylvania
Washington, D. C. Pittsburgh, Pa.
Dallas, Texas Paris, France

GANNETT FLEMING CORDDRY & CARPENTER, INC.
Engineers
Dams, Water Works, Sewage, Industrial Waste and Garbage Disposal—Highways Bridges and Airports, Traffic and Parking —Appraisals, Investigations, and Reports
HARRISBURG, PENNA.
Pittsburgh, Pa. Philadelphia, Pa.
Daytona Beach, Fla. Pleasantville, N.J.

GILBERT ASSOCIATES, INC.
Engineers and Consultants
Surveys—Design—Supervision
Sanitary Engineering
Industrials and Utilities
Domestic and Foreign
607 Washington St.
Reading, Pa.
New York — Washington

G. G. GREULICH
Consulting Engineer
Research, Development, and Market Surveys on Fabricated Metal Products. Pile Foundations, Cofferdams, and Bulkheads. Bridge Floors. Bank Vaults. Industrial Plants and Office Buildings
Two Gateway Center, Pittsburgh 22, Pa.

HUNTING, LARSEN & DUNNELLS
Engineers
Industrial Plants—Warehouses
Commercial Buildings—Office Buildings
Laboratories—Steel and Reinforced Concrete Design—Supervision Reports
1150 Century Bldg., Pittsburgh 22, Pa.

JUSTIN & COURTNEY
Consulting Engineers
Joel B. Justin Neville C. Courtney
Dams and Power Problems
Hydro Electric Developments
Foundations
121 S. Broad St. Philadelphia 7, Pa.

MORRIS KNOWLES INC.
Engineers
Water Supply and Purification
Sewerage and Sewage Disposal
Valuations, Laboratory, City Planning
1312 Park Bldg., Pittsburgh 22, Pa.

H. A. KULJIAN & COMPANY
Engineers and Architects
Power Plants (steam, hydro, diesel)
Industrial Buildings • Army & Navy Installations • Airports, Hangars
Water & Sewage Works
Design • Investigations • Reports • Surveys
1200 NO. BROAD ST. PHILA. 21, PA.

MODJESKI AND MASTERS
Consulting Engineers
F. M. Masters
G. H. Randall J. R. Giese
C. W. Hanson H. J. Engel
Design and Supervision of Construction
Inspection and Reports
Bridges, Structures and Foundations
State St. Bldg. Philadelphia, Pa.
Harrisburg, Pa. New Orleans, La.

C. W. RIVA CO.
Edgar P. Snow John F. Westman
Highways, Bridges, Tunnels, Airports, Sewerage, Water Supply, Soil Tests, Reports, Design and Supervision
5111 Westminister St. Prov. 3, R. I.

JACK R. BARNES
Consulting Ground-Water Engineer
Exploration—Evaluation—Development of Underground Water Supplies
308 W. 15th St. Tel. 7-5407
Austin, Texas 53-4751

ENGINEERS TESTING LABORATORY, INC.
Foundation and Soil Mechanics Investigations
Soil Borings Laboratory Tests
Foundation Analyses Reports
2116 Canada Dry St., Houston 23, Texas

WILLIAM F. GUYTON AND ASSOCIATES
Consulting Ground-Water Hydrologists
Underground Water Supplies.
Investigations, Reports, Advice.
307 W. 12th St. 3301 Montrose Blvd.
Austin 1, Texas Houston 6, Texas
Phone: GR 7-7165 Phone: JA 2-9885

LOCKWOOD & ANDREWS
Consulting Engineers
Industrial Plants, Harbors, Public Works
Roads, Airports Structures, Earthworks
Mechanical & Electrical
Reports—Design—Supervision
Surveys—Valuations
Corpus Christi-Houston-Victoria, Texas

McCLELLAND ENGINEERS
SOIL & FOUNDATION CONSULTANTS
INVESTIGATION • REPORTS
SUPERVISION • BORINGS & TESTS
2649 N. Main Houston 9, Tex.

NATIONAL SOIL SERVICES
Consulting Engineers
Soils—Foundations—Groundwater
Ralph F. Reuss Ray E. Hurst
Soil Borings Laboratory Tests
Foundation Analyses and Reports
Groundwater Exploration and Evaluation
M. & M. Building Houston, Texas

V. L. MINEAR
Consulting Engineer
Pressure Grouting, Foundations
Tunnels, Shafts.
Telephone 83W
226 N. 100 East St. St. George, Utah

USE THIS PROFESSIONAL CARD DIRECTORY

Participation is restricted to consulting engineering firms operated or controlled by members of the American Society of Civil Engineers

Your card should be among them.

Write Today For Rates.

Additional Professional Cards on Pages 141 and 142

Index to Advertisers

Acker Drill Company, Inc. 134
Aero Service Corporation 120
Allis-Chalmers Manufacturing Company 30
American Bitumuls & Asphalt Company 118
American Bridge Division 13
American-Marietta Company 97
American Pipe & Construction Co. . . . . 2nd cover
American Road Builders' Association 127
American Steel & Wire Division . . . . . 22 and 23
Armco Drainage & Metal Products, Inc. 113
The Asphalt Institute . . . . . 76 and 77

Baldwin-Lima-Hamilton Corp. 9
Bethlehem Steel Company . . . . . 8, 87 and 103
Bludworth Marine 126
Boeing Airplane Company 123
Borden Metal Products Company 2
C F Braun & Co. 126
Brown & Brown, Inc. 138

Cast Iron Pipe Research Association . . . . . 10 and 11
Caterpillar Tractor Co. . . . . 16 and 17
Cement Gun Company 110
Chicago Bridge & Iron Company 6
Chicago Pump Company 111
Columbia-Geneva Steel Division . . . . . 22, 23, 26 and 27
Concrete Reinforcing Steel Institute 25
Connors Steel Division, H. K. Porter Co., Inc. 106
Copperweld Steel Company 128
Ralph C. Coxhead Corp. 133

Eugene Dietzgen Company 138
Downey Missile Engineering 125

The Earle Gear & Machine Company 136
Economy Forms Corp. 136
Eimco Corporation 24

Fennel Instrument Corp. of America 137
Filotecnica Salmoiraghi, Inc. 135
Florida Division, Food Machinery & Chemical Corp. 91
L. B. Foster Co. 119
Franki Foundation Company 19

Gahagan Dredging Corp. 133
Gar-Bro Manufacturing Co. 112
Geo-Optic Co., Inc. 131
Gruman Aircraft Engineering Corp. 124
W. & L. E. Gurley 92

Rodney Hunt Machine Co. 100

Imperial Tracing Cloth. 129
The Ingalls Iron Works Company 115
International Harvester Company . . . . . 4 and 5
Intrusion-Prepakt, Inc. 95
Irving Subway Grating Co., Inc. 136

Johns-Manville Corporation 121

Kern Instrument, Inc.. 132
Keuffel & Esser Co. 98
The Kinnear Mfg. Co. 96
Klemp Metal Grating Corporation 129

The James Leffel & Co. 93
Leupold & Stevens Instruments, Inc.. 106
Link-Belt Company . . . . . 14 and 15
Lock Joint Pipe Company . . . . . 4th cover
Lone Star Cement Corporation 32

Madsen Works, Baldwin-Lima-Hamilton Corp. 9
Masonry Resurfacing and Construction Co., Inc. 20
The Master Builders Co. . . . . 3rd cover
Mayo Tunnel & Mine Equipment 129
Moretrench Corporation 132

Naylor Pipe Company 116
Newport News Shipbuilding and Dry Dock Company . . . 12

Opla Company 110

Pennsylvania Drilling Co. 131
Pittsburgh-Des Moines Steel Co. 117
Portland Cement Association 101

Ranney Method Water Supplies, Inc. 128
Raymond Concrete Pile Co. 29
Reynolds Metals Co. 18
H. H. Robertson Company 81
Russell, Burdsall & Ward Bolt & Nut Co. 1

The Salem Tool Company 132
Sika Chemical Corp. 89
S. Morgan Smith Co. 105
Sonoco Products Company 102
Spencer, White & Prentis, Inc. 104
J. S. Staedtler, Inc. 138
John W. Stang Corporation 107
Superior-Lidgerwood-Mundy Corp. 137
Symons Clamp & Mfg. Co. 135

Tennessee Coal & Iron Division . . . . . 22, 23, 26 and 27
The Texas Company 79

United States Pipe and Foundry Co. 7
United States Steel Corporation . . . . 13, 22, 23, 26 and 27
United States Steel Supply Division . . . . . 26 and 27
United States Steel Export Company . . 13, 22, 23, 26 and 27
Universal Form Clamp Co. 99

Warren-Knight Company 128
C. H. Wheeler Manufacturing Company 131
David White Company 21
Wild Heerbrugg Instruments, Inc. 114
John Wiley & Sons, Inc. 28
R. D. Wood Company. . . . . 108 and 109

Yuba Manufacturing Co. 94

Professional Services . . . . . 141, 142 and 143

Advertising Manager

James T. Norton

Advertising Production Manager

Alice M. Doerle
33 West 39th Street, New York 18, N. Y.

Representatives

EASTERN

• ROBERT S. CYPHER
33 West 39th Street, New York 18, N. Y.

SOUTHEASTERN

• Fred W. Smith
1212 41st St., B. H.
Birmingham 8, Ala.

MID-WESTERN

• DWIGHT EARLY AND SONS
100 North La Salle St., Chicago 2, Ill.

WESTERN

• McDONALD-THOMPSON COMPANY
625 Market St., San Francisco 5, Calif.
3727 West Sixth St., Los Angeles 5, Calif.
National Bldg., 1008 Western Ave., Seattle, Wash.
5526 Dyer Street, Dallas 6, Texas
3217 Montrose Boulevard, Houston 6, Texas
Colorado National Bank Bldg., Denver 2, Colo.

Louisiana State Penitentiary, Angola, La.; Archts. & Engrs.—Curtis & Davis; Consltg. Engrs.—Cary B. Gamble & Associates and Walter E. Blessey; Contr.—R. P. Farnsworth & Co.—all of New Orleans, La.

POZZOLITH in lift slab concrete for optimum results

Lift slab construction at its best—with Pozzolith—here and in many other types of projects, because Pozzolith improves engineers' control of concrete quality.

Pozzolith is the key to...

- ★ lowest possible unit water content
- ★ close control of entrained air...placing consistency...rate of hardening
- ★ reduced costs

Over 115 million cubic yards of concrete have been produced with Pozzolith for all types of work—evidence of Pozzolith's dependable performance.

Any one of our more than 75 field technical men will be glad to demonstrate the full advantages of Pozzolith for your project.

THE MASTER BUILDERS CO.

CLEVELAND 3, OHIO • TORONTO, ONT. | Division of American-Marietta Company | Cable Address, Mastmethod, New York

NO MATTER HOW YOU FIGURE IT...

When you undertake the purchase of a new pipeline for your water supply system, do you figure from the financial angle—low first cost, economical installation and a long life for your investment?

Or are you more interested in the construction of the line—minimum excavation, easy assembly, and watertight joints in a pipe strong enough to withstand high pressures and heavy external loads?

Then, again, your specialty may be maintenance. In that case you probably figure minimum repairs through freedom from breaks and leaks to be of paramount importance.

Or is your main concern with operation? If so, you no doubt figure permanent high carrying capacity, low pumping costs and trouble-free service to be vital.

Still, *no matter how you figure it*, your best answer will always be LOCK JOINT CONCRETE PRESSURE PIPE, because it most nearly approximates the ideal pressure pipe for water works systems.

LOCK JOINT PIPE CO.

East Orange, New Jersey

Sales Offices: Chicago, Ill. • Columbia, S. C. • Denver, Col. • Detroit, Mich. • Hartford, Conn. • Kansas City, Mo.

Pressure • Water • Sewer • REINFORCED CONCRETE PIPE • Culvert • Subaqueous